

TEKTRONIX®

221

OSCILLOSCOPE

SERVICE

INSTRUCTION MANUAL

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Fig. 1-1. The Tektronix 221 Oscilloscope.

OPERATING INFORMATION AND SPECIFICATIONS

INTRODUCTION

The 221 Oscilloscope is a single-channel, five megahertz portable instrument using all solid state and integrated circuit components (except the crt). The instrument is mechanically constructed to withstand the shock, vibration, and other extremes associated with portability.

The dc to five megahertz vertical system provides vertical deflection factors from five millivolts to 100 volts/division at the tip of the integral high-impedance probe. The trigger circuit provides stable triggering over the full range of vertical frequency response.

The horizontal deflection system provides calibrated sweep rates from 200 milliseconds to one microsecond/division. A sweep variable decreases calibrated sweep rates by about 2.5:1, resulting in a minimum uncalibrated sweep rate of about 0.5 second/division. A calibrated X10 sweep magnifier increases the sweep to at least 0.1 microsecond/division. In addition, horizontal amplifier operation provides a horizontal deflection factor of one volt/division for X-Y operation. The cathode-ray tube has a six by ten division graticule (each division equals approximately 0.2 inch).

The 221 is operated either from ac line voltage or from internal rechargeable batteries. The internal batteries are recharged from the ac power line by the integral battery charger (with the instrument on or off).

This instrument will meet the following electrical characteristics after complete instrument calibration. These characteristics apply over an ambient temperature range of -15°C to $+55^{\circ}\text{C}$ ($+5^{\circ}\text{F}$ to $+131^{\circ}\text{F}$) when battery operated, or 0°C to $+40^{\circ}\text{C}$ ($+32^{\circ}\text{F}$ to $+104^{\circ}\text{F}$) when the instrument is connected to ac line voltage. Warmup time for given accuracies is five minutes.

ELECTRICAL

The 221 oscilloscope will meet the following electrical specifications after calibration. The check portion of the calibration procedure provides a convenient method of checking instrument performance without making internal checks or adjustments.

The following electrical characteristics apply over an ambient temperature range of -15°C to $+55^{\circ}\text{C}$ ($+5^{\circ}\text{F}$ to $+131^{\circ}\text{F}$) battery operation, or 0°C to $+40^{\circ}\text{C}$ ($+32^{\circ}\text{F}$ to $+104^{\circ}\text{F}$) for line voltage operation.

Vertical Deflection System

Calibrated Range: five millivolts to 100 volts/division in 14 steps.

Accuracy: within 3% with VAR VOLTS/DIV in CAL detent position.

Uncalibrated VAR VOLTS/DIV range: Continuously variable, 3:1 minimum.

Bandwidth (with six division reference): to at least five megahertz (-3 dB point), with VARIABLE VOLTS/DIV in CAL position.

Step Response: 70 nanoseconds or less.

Aberrations: $+5\%$, -5% , 5% peak to peak total.

Input Resistance: 1 megohm.

Input Capacitance: Approximately 29 picofarads.

Maximum Safe Input Voltage: 600 volts (dc + peak ac), 600 volts peak-to-peak ac.

Triggering

Trigger Sensitivity:

INT: 0.5 divisions from two hertz to one megahertz, increasing to 1 division at five megahertz.

EXT: 0.5 volt from dc to one megahertz, increasing to 1 volt at 5 megahertz.

AUTO PRESET: Triggered at preset level on positive slope of waveform.

Display Jitter: 20 nanoseconds or less.

EXT TRIGGER:

Input Resistance: Approximately one megohm.

Input Capacitance: Approximately 30 picofarads.

Maximum Usable Input Voltage: Three volts (dc + peak ac), six volts peak-to-peak ac (five megahertz or less).

Horizontal Deflection System

Sweep Generator:

Calibrated Range: 200 milliseconds to one microsecond/division in 17 steps.

Accuracy (over center eight divisions): Within 3% with VAR SEC/DIV in the CAL position.

Linearity (any two division portion, within the center eight divisions): Within 3%, disregard first 1 microsecond of sweep.

SEC/DIV VAR (Variable): Continuously variable between calibrated setting of the SEC/DIV switch. Extends minimum sweep rate to approximately 0.5 s/div. Each sweep rate is decreased 2.5:1.

Horizontal Magnifier (HORIZ-MAG 10X): Calibrated magnifier when SEC/DIV is in CAL detent. Accuracy within 5%, disregard the first 1 microsecond of the sweep.

External Horizontal Input:

Deflection Factor: One volt/div 1X, 0.1 volt/div 10X. Accuracy within 10%.

Bandwidth: With six division reference dc to 500 kilohertz.

Input Resistance: Approximately 500 kilohms.

Input Capacitance: Approximately 30 picofarads.

Maximum Safe Input Voltage: 200 volts (dc to peak ac), 200 volts peak-to-peak ac.

Maximum Usable Input Voltage: Approximately \pm nine volts.

Display

Graticule:

Type: Internal back line, non-illuminated.

Area: Six vertical divisions by 10 horizontal divisions.

Phosphor: P31 Standard.

Power

Line Voltage Operation:

Line Voltage Range: 90 V to 250 V ac; 80 V to 250 V dc.

Line Frequency Range: 48 to 62 Hertz.

Maximum Power: Five watts.

Line Fuse: 0.2 A 250 V.

Common Isolation:

Line Operation: Line voltage plus floating voltage not greater than 250 volts RMS sine wave, or 1.4 times line voltage + dc + peak ac floating voltage not greater than 350 volts.

Battery Operation: Common to outside of case floating voltage not greater than 500 volts RMS or 700 volts dc + peak ac.

Battery Operation:

Batteries: Ten rechargeable A nickel-cadmium cells.

Charge time: 16 hours for full charge.

Battery Charge Indicator: Battery meter indicates Full, Low and Recharge. Recharge is indicated after automatic shut-off turns instrument off.

Battery Discharge Charge Protection: Instrument operation automatically interrupted when battery charge is less than 10 volts.

Typical Operating Time (after full charge cycle at +20°C to +30°C): Two to three hours. Longest operating time provided at low trace intensity.

Typical Charge Capacity:

(Referenced to charge/discharge at +20°C to +30°C):

TABLE 1-1

CHARGE TEMPERATURE	OPERATING TEMPERATURE		
	+15°C	+20°C to +30°C	+55°C
0°C (+32°F)	40%	60%	50%
+20°C to +30°C (+68°F to +86°F)	65%	100%	85%
40°C (+104°F)	40%	65%	55%

PHYSICAL

Temperature:

Operating from Batteries, -15°C to $+55^{\circ}\text{C}$ ($+5^{\circ}\text{F}$ to $+131^{\circ}\text{F}$).

Charging or operating from ac line, 0°C to $+40^{\circ}\text{C}$ ($+32^{\circ}\text{F}$ to $+104^{\circ}\text{F}$).

Storage, -40°C to $+60^{\circ}\text{C}$ (-40°F to $+140^{\circ}\text{F}$).

Altitude:

Operating, to 25,000 feet (maximum operating temperature decreased by 1°C per 1,000 feet shown above 15,000 feet).

Non-operating, to 50,000 feet.

Humidity (operating and non-operating): 5 days 50°C to 95% relative humidity.

Shock (operating and non-operating): Tested with two shocks at 100 g, one-half sine, two millisecond duration each direction along three major axes.

Weight (without accessories):

3.5 pounds (1.5 kilograms)

Dimensions (measured at maximum points):

Height: 3.0 inches (7.6 centimeters).

Width: 5.25 inches (13.2 centimeters).

Depth: 9.0 inches (22.8 centimeters).

FUNCTIONS OF CONTROLS AND CONNECTORS

All controls and connectors necessary for operation of the 221 are located on the right side panel of the instrument. See Fig. 2-1. A brief description of each control and connector is given here.

VOLTS/DIV—selects vertical deflection factor (VAR VOLTS/DIV must be in the CAL position for indicated deflection).

STEP ATTEN BAL—screwdriver adjustment to balance the vertical system for minimum trace shift when changing deflection factors.

Vertical POS—controls the vertical position of the trace.

VERT GAIN—screwdriver adjustment to set the gain of the vertical system.

VAR VOLTS/DIV—provides a continuously variable deflection factor between the calibrated settings of the VOLTS/DIV switch.

INPUT COUPLING—selects method used to couple the input signal to the vertical amplifier system.

AC—blocks dc components of input signal. Low frequency limit (−3 dB point) is about two hertz.

GND—Input circuit is grounded. The applied signal is connected to ground through a large resistor to provide a precharge path for the AC input coupling capacitor.

DC—All components of the input signal are passed to the vertical amplifier system.

SEC/DIV selects the sweep rate (VAR SEC/DIV must be in the CAL detent; **HORIZ MAG** must be in X1 position, for indicated sweep rate). 1 V position allows for X-Y operation with the horizontal deflection provided by the signal connected to the **EXT TRIG OR HORIZ INPUT** jack.

Horizontal POS—controls the horizontal position of the trace.

VAR SEC/DIV—provides continuously variable sweep rates between calibrated settings of the SEC/DIV switch. Extends the minimum sweep rate to about 0.5 second/division.

HORIZ MAG—X10 magnifier to increase the maximum sweep time to 0.1 microsecond/division and provides a horizontal sensitivity of 0.1 volt/division in X-Y operation.

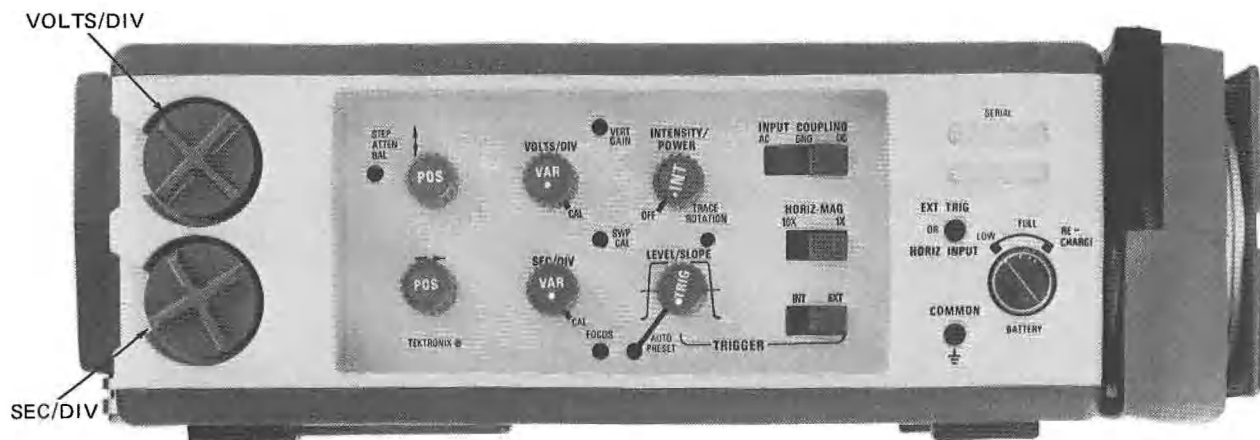


Fig. 2-1. Side panel showing controls and connectors.

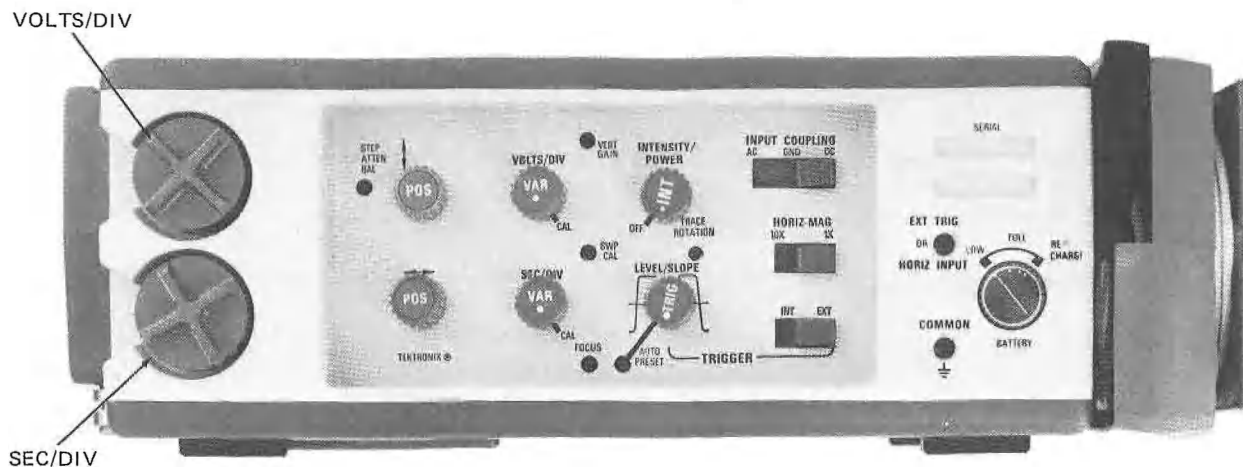


Fig. 2-2. Side panel showing controls and connectors.

SWP CAL—screwdriver adjustment to set the basic timing of the horizontal system.

TRACE ROTATION—screwdriver adjustment to align trace with graticule lines.

EXT TRIG OR HORIZ INPUT—banana jack for input of an external trigger signal or for input of an external horizontal (X) signal for X-Y operation.

LEVEL/SLOPE—selects the amplitude point and slope of the trigger signal on which the sweep is triggered. When the indicator dot is to the left of center, the sweep is triggered on the positive-going slope of the trigger signal; to the right of center, on the negative-going slope. When the LEVEL/SLOPE control is set to the AUTO PRESET detent, the sweep is automatically triggered at a preset level on the positive-going slope.

AUTO PRESET—screwdriver adjustment to set the PRESET trigger point for AUTO sweep operation.

EXT-INT—selects the source of the trigger signal.

INTENSITY—controls brightness of crt display (detent turns OFF instrument power).

FOCUS—screwdriver adjustment to obtain a well-defined display.

BATTERY—expanded scale meter to indicate the relative charge level of the internal batteries.

POWER—(counterclockwise detent of the INTENSITY control). Controls power to the instrument. Does not interrupt charging current to the internal batteries when connected to an AC line voltage.

COMMON—banana jack to establish common ground between the 221 and the external signal source or equipment under test.

PREVENTIVE MAINTENANCE

Preventive maintenance, when performed on a regular basis, can prevent instrument breakdown and may improve the reliability of the 221. The severity of environment to which this instrument is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is preceding recalibration of the instrument.

Disassembly

To gain access to the interior of the instrument, unwind the probe and the power cord from the rear of the instrument. Remove the five screws in the bottom cover of the instrument. See Fig. 3-1. Gently separate the bottom cover from the instrument and lay aside.

If access to the front of the Input circuit board is necessary, remove the knobs from all of the external control shafts. Remove the two screws securing the side panel to the Input circuit board and remove the instrument side panel.

Cleaning

The 221 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause component breakdown.

The high impact plastic covers provide protection against dust in the interior of the instrument. Loose dust accumulated on these covers can be removed with a soft cloth or small brush. The brush is also useful for dislodging dirt on and around the side panel controls. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

Cleaning the interior should only be occasionally necessary. The best way to clean the interior is to blow off the dust with a dry, low-velocity stream of air. A soft-bristle brush or a cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning more delicate components.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain hydrochloric acid, sodium hydroxide, or sulfuric acid.

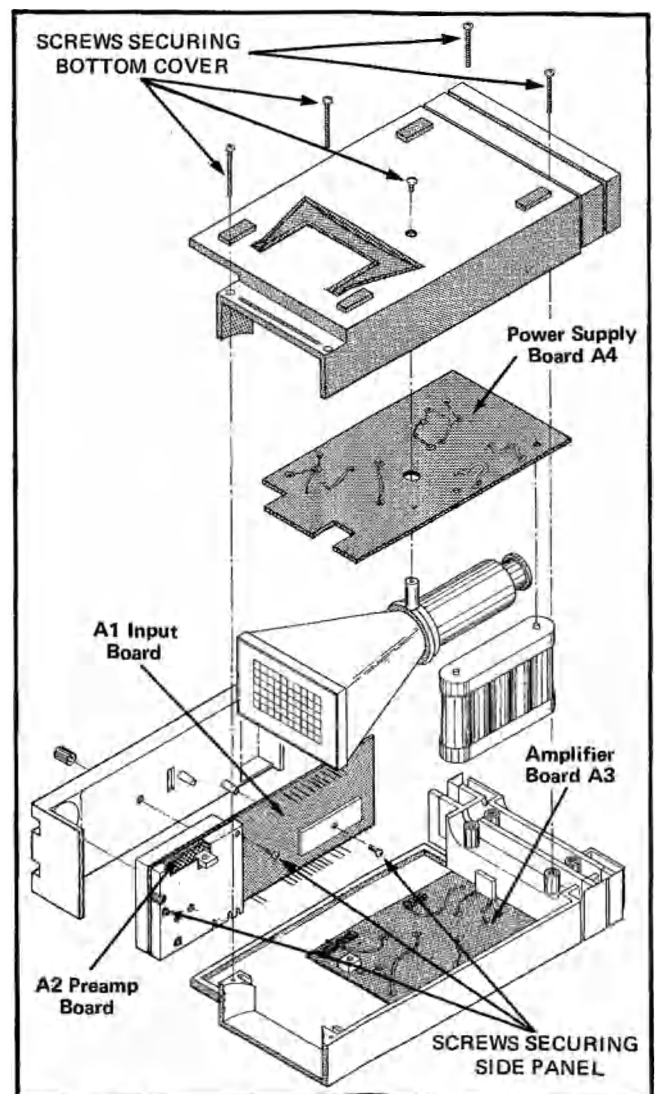


Fig. 3-1. Location of screws securing bottom cover and side panel (instrument shown upside down).

Visual Inspection

The 221 should be inspected occasionally for such defects as broken connections, improperly seated transistors, damaged circuit boards, and heat-damaged parts. The corrective procedure for most visible defects is apparent; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, correcting the cause of the overheating is important to prevent recurrence of the damage.

Semiconductor Checks

Periodically checking the semiconductors in the 221 is not recommended. The best check of semiconductor

performance is actual operation in the instrument. If checking the performance of a semiconductor out of the instrument is desired, a dynamic checker, such as the Tektronix Type 577 Curve Tracer system, is recommended. Lead configurations of the semiconductors used in the 221 are shown in Fig. 3-2.

An extracting tool should be used to remove the eight-pin flat integrated circuit to prevent damage to the pins. If an extracting tool is not available when removing one of these integrated circuits, pull slowly and evenly on both ends of the device. Avoid having one end of the integrated circuit disengage from the socket before the other, as the pins may be damaged. When replacing semiconductors, key the semiconductor index with that of the socket. Failure to do so will result in damaged components.

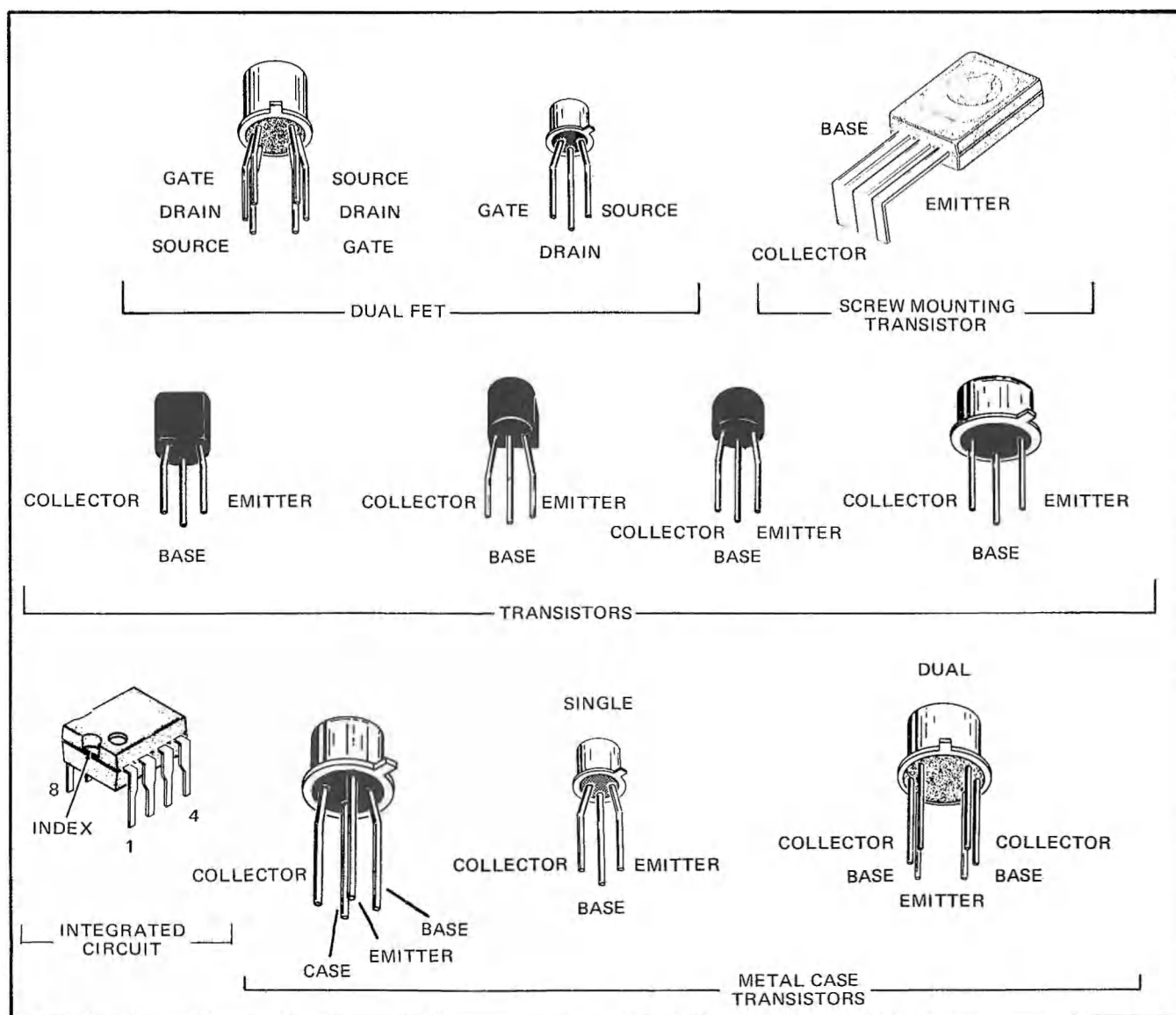


Fig. 3-2. Lead configurations of the semiconductors used in the 221 Oscilloscope.

Recalibration

To ensure accurate measurements, check the calibration of this instrument after each 1000 hours of operation, or every six months if used infrequently. In addition, replace-

ment of components may necessitate recalibration of the affected circuits. The Calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed or corrected by recalibration.

CIRCUIT DESCRIPTION

The following circuit description begins with a discussion of the instrument using the block diagram. Then each circuit is described in detail, using detailed diagrams where necessary to show the relationship of each stage and the controls to that stage. The block diagram is shown in Section 9.

BLOCK DIAGRAM

Signals to be displayed on the crt are applied to the probe tip. The signal is then amplified by the vertical amplifier. The vertical amplifier contains the vertical position, attenuation, gain compensation, and input coupling circuitry.

The Trigger Generator initiates the sweep signal produced by the sweep generator. The input signal to the trigger generator is selected from the vertical signal or from an external signal applied to the EXT TRIG connector.

The Sweep Generator circuit produces a linear sawtooth signal that is amplified by the Horizontal Amplifier circuit. The slope of the sawtooth generator is controlled by the SEC/DIV switch. This circuit also produces the unblanking signal coincident with the sawtooth to permit display presentation.

The power supply circuit provides all the voltage necessary for the operation of the instrument. Input power is provided by internal batteries or a line source. This circuit also provides a recharging circuit for the internal batteries.

CIRCUIT OPERATION

The following is a description of the electrical operation and relationship of the circuits in the 221 with a description of the circuitry most commonly used by Tektronix. If more information is desired on the commonly used circuit, refer to the following textbooks:

Phillip Cutler, "Semiconductor Circuit Analysis", McGraw-Hill, New York, 1964.

Vertical Amplifier

The Vertical Amplifier circuit is divided into three sections; the attenuators, the Preamplifier, and the Output Amplifier. A block diagram of the Vertical Amplifier is shown in Fig. 4-1. Schematics of the Vertical Amplifier are shown on diagrams 1 and 3.

The input signals are applied to a 800 kilohm impedance in the probe and a 200 kilohm attenuator network, which provides the 1 megohm impedance for the oscilloscope. The output of the attenuator is applied to the input of the Preamplifier, which consists of three sections; the buffer amplifier (Q132A and B, Q136A and B), a resistive attenuator (R143-R156), and an operational amplifier (Q162A and B, Q172A and B, and Q164). The Preamp stage also provides Probe compensation, Attenuator compensations, Step Attenuator Balance, Volts/Div Balance, and Vertical Step Response (C167).

Output signals from the resistive attenuator are applied to the positive input of the operational amplifier (Q162A base). The output signal (from collector Q164) is then applied to both the input of the output amplifier (base Q422A) and, through feedback network R166 and R167, to the negative input of the operational amplifier (base of Q162B). Transistor Q172A and B serve as dc biasing circuitry for these amplifiers.

The Output Amplifier provides the final amplification for the crt deflection plates and consists of three amplifier stages. Transistors Q422A and B, Q426A and B, and Q424 are connected as an operational amplifier, with resistors R416, R417, R418, and R432 serving as the feedback network. It is otherwise similar in operation to the operational amplifier described for the Preamplifier stage. The operational amplifier drives a differential amplifier (Q442A and B), which in turn drives a dual output amplifier. The Output Amplifier stage also provides the circuitry for the bandwidth adjustment (C432), the VERTICAL POSITION control (R413), the Vertical Gain control (R417), and the VOLTS/DIV VARIABLE control (R418). Transistor Q432 is connected as an emitter follower and provides the internal trigger signal for the trigger circuitry.

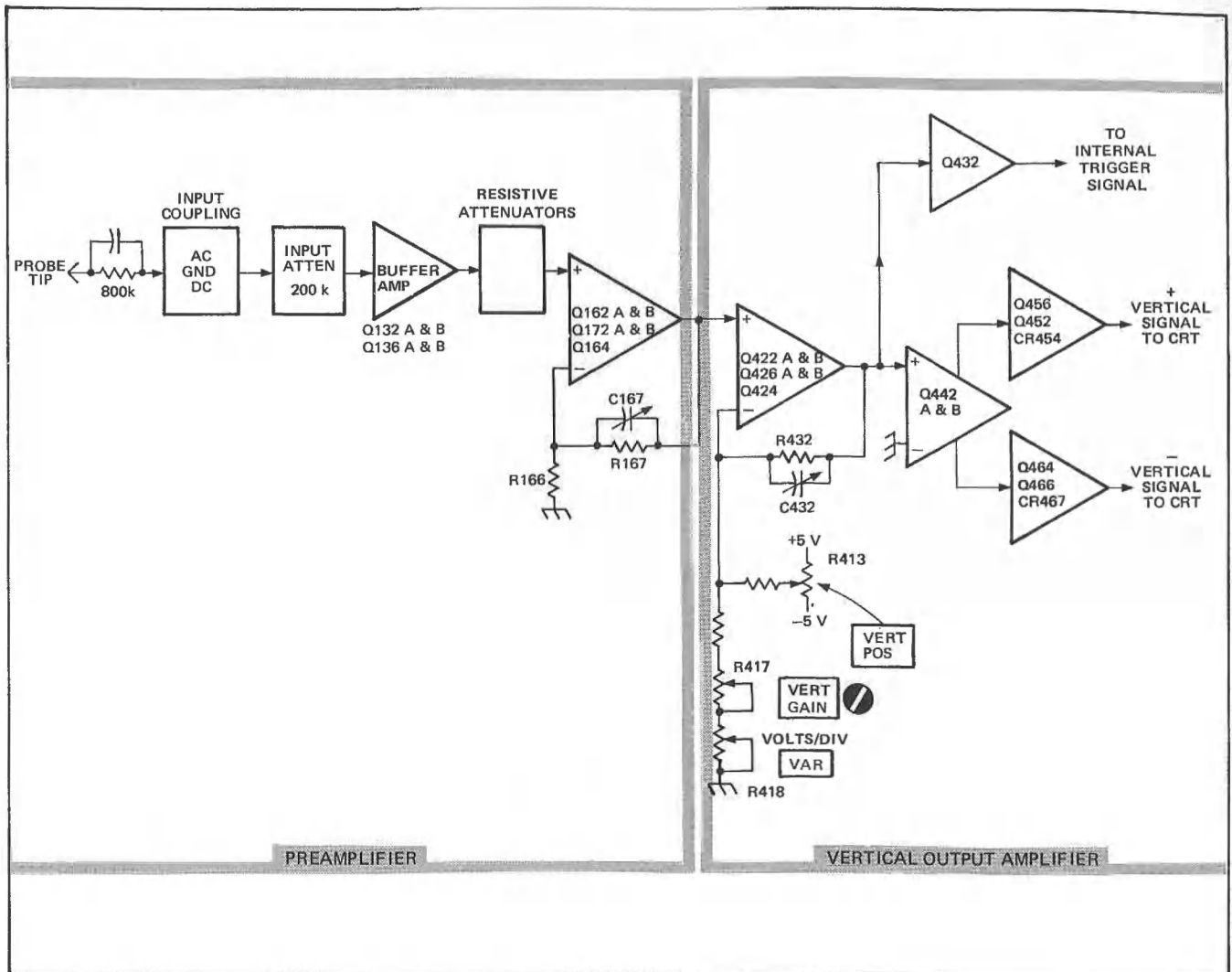


Fig. 4-1. Simplified block diagram of the Vertical Amplifier circuit.

One half of the dual output amplifier stage is an operational amplifier consisting of transistors Q452, Q456, and diodes CR454-CR455, which provide the amplification for the positive signal to the crt vertical deflection plate. Likewise, transistors Q464, Q466, and diodes CR467-CR468 make up the other half of the operational amplifier, which serves the same function for the negative vertical deflection plate. Both amplifiers operate the same, so only the positive signal amplifier will be explained.

Under normal signal conditions, the voltage on the positive deflection plate is maintained by the emitter follower Q456. The output signal from the differential amplifier (collector Q442A) is applied to the input of the operational amplifier (base Q452). Feedback resistor R456

receives a common output signal from the collector of Q452 and the emitter of Q456. Under fast, positive output signal conditions, the deflection plate is driven through the emitter follower Q456. Under fast negative signal conditions the collector of Q452 goes negative, and turns on a commutating diode CR454, which turns off Q456 through diode CR455, and thereby allows the collector of Q452 to drive the deflection plate.

Transistors Q452, Q456, Q464, and Q466 are specially selected transistors for a low C_{ob} (0.3 pf max.), a 500 Megahertz F_t and a V_{cbo} and V_{cev} not less than 80 volts. The lead configuration is BECS with the emitter and shield leads tied together on the printed circuit board.

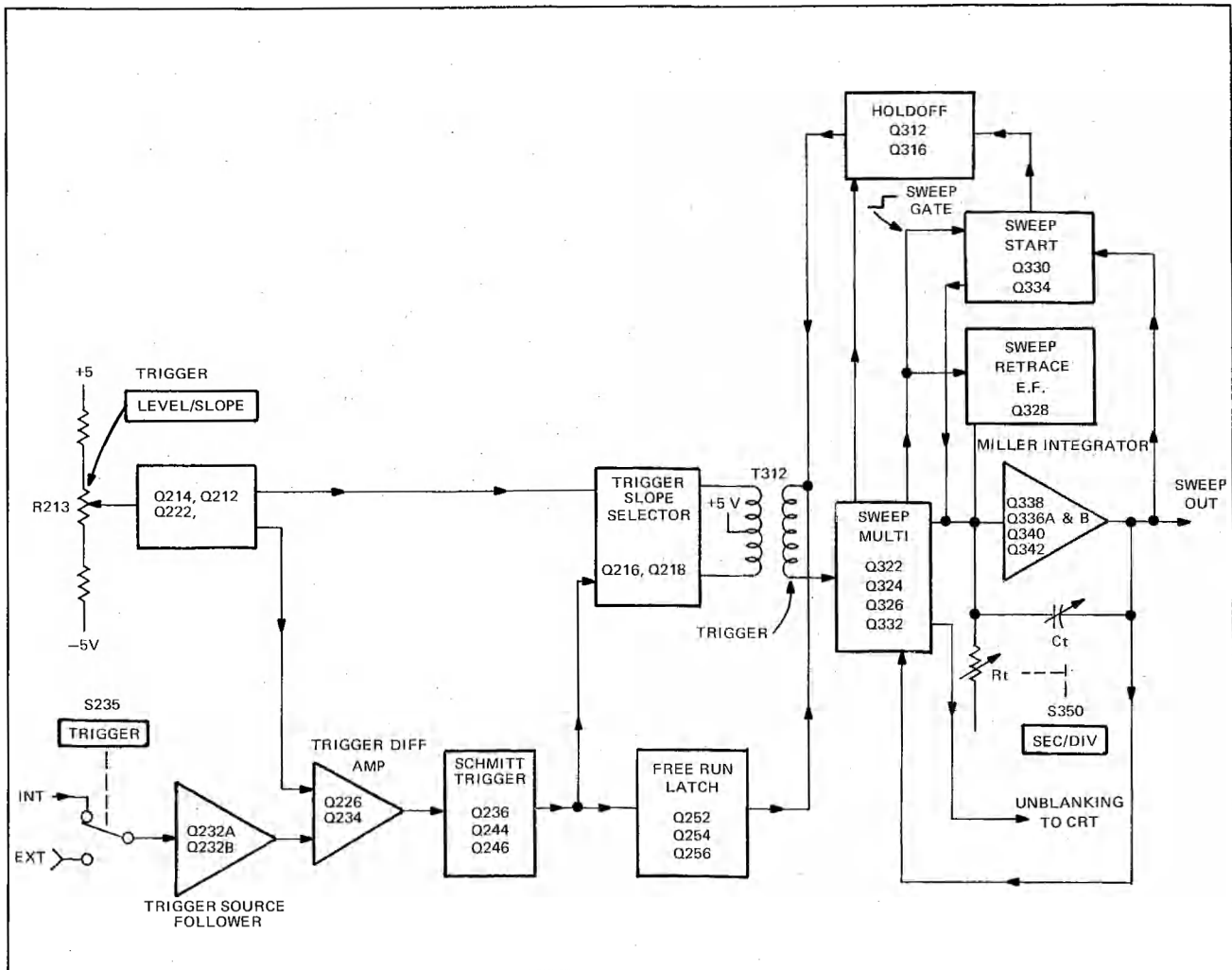


Fig. 4-2. Simplified block diagram of the Trigger Sweep circuit.

Trigger/Sweep

The Trigger Sweep circuit performs two functions. The Trigger portion of the circuit derives trigger signals internally from the input of the vertical amplifier, or from signals applied to the EXT TRIG INPUT banana jack. The trigger output signals are coupled to the Sweep Multi circuit, which starts the action of the Sweep circuit.

The Sweep portion of the circuit produces a linear sawtooth output signal when initiated by the Trigger circuit. The output signal is then amplified by the Horizontal Amplifier circuit for horizontal deflection of the crt. An unblanking gate signal is also developed that is coincident with the sawtooth waveform. This gate signal unblanks the crt to permit a display presentation. An EXT HORIZ INPUT is also provided so external signals can be applied to the Horizontal Amplifier circuit to produce horizontal deflec-

tion for the crt. The block diagram of the Trigger/Sweep circuit is shown in Fig. 4-2. The schematic of the circuit is shown on diagram 2.

The Trigger Source Follower (Q232A, Q232B) receives and buffers all incoming trigger signals and couples them to the base of Q234, one half of a differential amplifier (Q234 and Q226). TRIGGER LEVEL/SLOPE control R213 sets a reference voltage level that corresponds to a desired trigger point on the incoming signal. This voltage is coupled through Q212 to the base of Q226, the other half of the differential amplifier. Transistor Q214 provides a slope switching function in conjunction with Trigger Slope Selector transistors Q216 and Q218. When TRIGGER LEVEL/SLOPE control R213 is rotated, the resulting voltage applied to the base of Q222 causes it to saturate at about the mid-point, or a zero volt level of the control. At this point Q214 turns on and slope switching occurs through Q216 or Q218.

Circuit Description—221 Service

The output of the differential amplifier (Q226-Q234) is coupled through emitter follower Q236 to the Schmitt Trigger, composed of transistors Q244 and Q246. This circuit controls the action of the Sweep Multi. When Q246 turns on, Trigger Slope transistors Q216 (–Slope) or Q218 (+Slope) will conduct. This couples the output through T312, changes CR317 to a high state, and generates a trigger pulse for the Sweep Multi. Diode CR317 returns to the low state when Hold-off transistor Q312 becomes turned off.

The Sweep Multi circuit composed of transistors Q322, Q324, and Q326 drives the Sweep Start transistors Q330 and Q334, which produce an unblanking signal for the crt and sets the sweep start voltage for the Miller Integrator. When the sweep is triggered, transistor Q322 is turned off and Q324 turns on. Transistor Q332 then charges up sweep hold-off capacitors C325, C326, and C327. Transistor Q334 turns off Q328 and Q330. The Miller Integrator is composed of Q336A and B, Q338, Q340, and Q342. Transistor Q316 is turned off and Q312 is turned on. This resets CR317 to its low state, inhibiting any further trigger pulses. The sweep is now set for the run-down. As the sweep runs down, Q324 becomes turned off by the current through CR328 and R328. When Q324 turns off, Q322 turns on. Transistor Q328 also turns on and supplies

retrace current through R333. The sweep runs back up until Q330 turns on and sets the sweep start voltage. The retrace current from the collector of Q330 then discharges the sweep start hold-off capacitors. When transistor Q316 turns on and Q312 off, the trigger pulses are no longer inhibited.

The Latch circuit composed of transistors Q252, Q254, and emitter follower Q256, controls the Sweep Multi operation in the Auto Preset position. The output of Q244 turns on the Latch transistors and discharges C256, the free-running hold-off capacitor, when S213B is in the open position (Auto Preset mode). In the closed position, S213B keeps C256 from being charged through resistor R256, permitting trigger pulses to initiate the circuit action. Emitter follower Q256 changes CR317 to its high state (in the absence of trigger pulses) through R258, R316, and the secondary of T312.

In the EXT Sweep mode of operation, CR228 is connected to –5 volts by S350, which turns off the trigger amplifier. Transistor Q322 is turned off by R318 and CR318, turning on Q324 to unblank the crt. Transistor Q328 is turned off, which turns off the retrace current, permitting the Miller Integrator to be connected as an inverting operational amplifier.

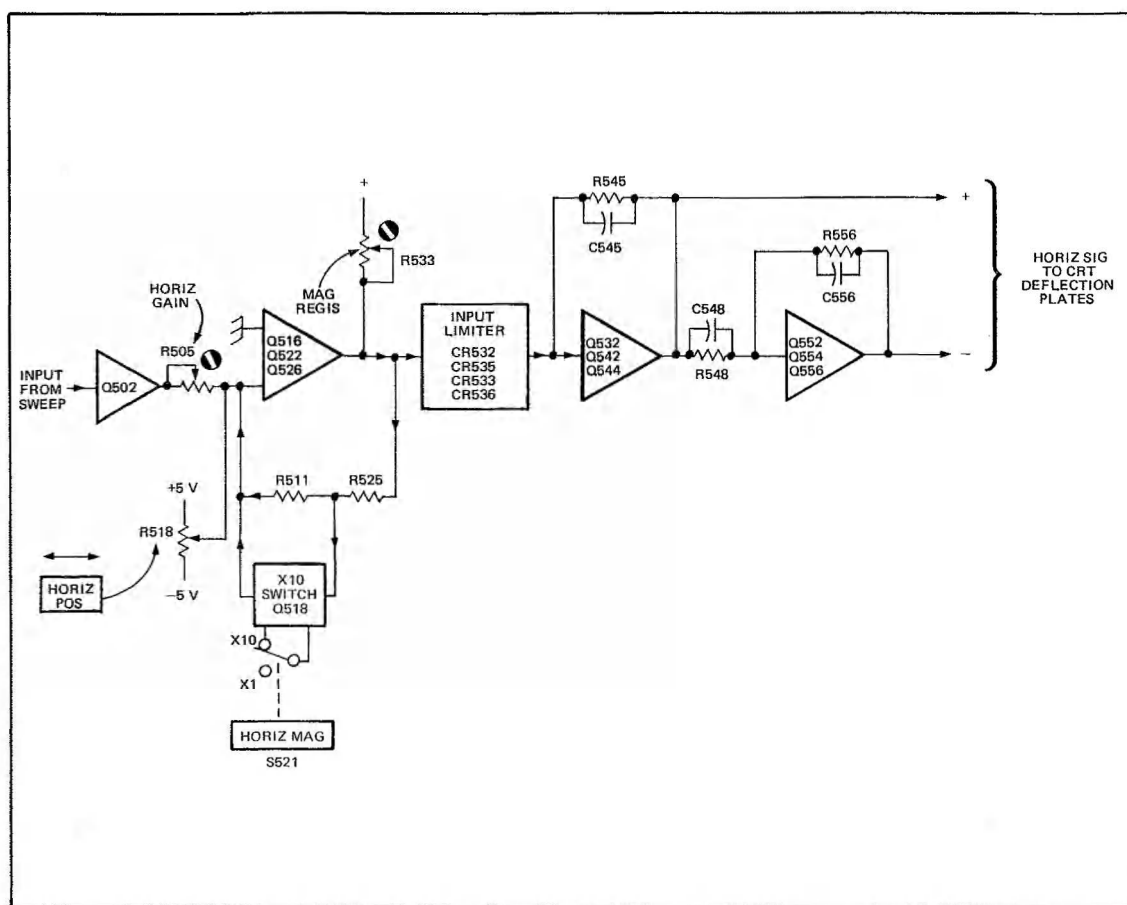


Fig. 4-3. Simplified block diagram of the Horizontal Output Amplifier circuit.

Horizontal Amplifier

The Horizontal Output Amplifier provides amplification for the sweep signal or the horizontal signal (used in the X-Y mode), to drive the crt deflection plates. A block diagram of the Horizontal Output amplifier is shown in Fig. 4-3. The schematic is shown on diagram 3.

Transistor Q502 is connected as a buffer amplifier between the sweep generator and the horizontal amplifier. The horizontal amplifier consists of three operational amplifiers. Transistors Q516, Q522, and Q526 are connected as the first operational amplifier that controls the horizontal gain, positioning, and magnification.

Resistors R504 and R505 serve as the input resistance to the amplifier. The feedback resistance (R525, CR525, and R511) is connected from the emitter of Q526 back to the operational amplifier input (emitter Q516), and determines the gain for the X1 and X10 mode. In the X1 mode, Q518 is turned on and shorts R511. In the X10 mode, Q518 is turned off, adding R511 to the feedback resistance. Horizontal Position control R518 applies an offset current to the input of the operational amplifier for the required dc positioning.

Current output from the collector of Q526, which is proportional to the output signal, is applied through the diode limiter CR532, CR533, CR535, and CR536 to the input of the second operational amplifier.

Transistors Q532, Q542, and Q544 are connected as the second operational amplifier, which drives the input resistance (R548) of the third operational amplifier and the positive deflection plate. Resistor R545 serves as the amplifier feedback resistance, with R542 and C542 providing the High Frequency signal path for the positive going output signal.

The third operational amplifier consists of transistors Q552, Q554, and Q556, with R548 being the input resistance and R556 the feedback resistance. It is connected as an inverting amplifier with a gain of one, and drives the negative deflection plate. This amplifier operates similarly to the vertical deflection plate drivers described in the Vertical Amplifier section.

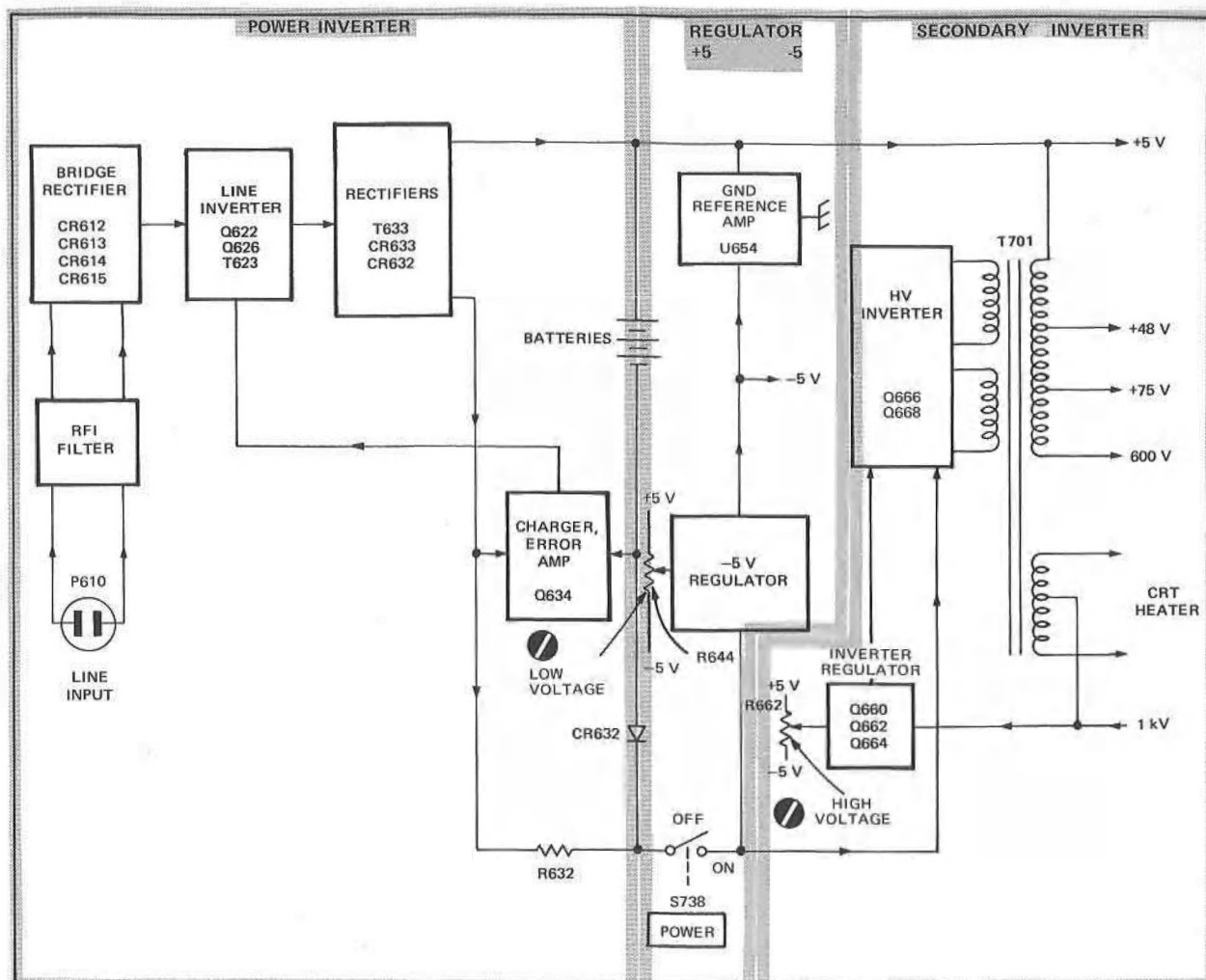


Fig. 4-4. Simplified block diagram of the Power Supply circuit.

CAUTION

The circuit from the power line to the primary of T633 is floating at line potential. Any signal measurement in this circuit must be referenced to pin 1 of T633, and should be measured only if an Isolation transformer is used on the power line.

Power Supply

The 221 Power Supply circuit is divided into three sections; the Power Inverter, the +5 V—5 V Regulator, and the HV Inverter. A block diagram of the Power Supply is shown on Fig. 4-4. The schematic of the Power Supply is shown on diagram 4.

When the instrument is connected to a power source, C612, R612, C613, R613, R614, L610, and C614 function as a RFI filter to minimize RFI interference. The line voltage is rectified by diode bridge CR612, CR613, and CR615, which supplies the dc voltage for the Line Inverter circuit. Transistors Q622 and Q626 convert the dc voltage into a square-wave voltage. The square-wave voltage is applied to an LC resonant circuit consisting of C623 and T633. Feedback is provided from T633, through R626, back to the base drive transformer T623, to sustain the oscillation. As the output power changes, the frequency of the square-wave changes with respect to the resonance of L (T633) and C (C623), permitting the Power Inverter to remain constant. In this way a correct output level is maintained over the specified line voltage range and operating conditions.

The output of the Power Inverter is rectified by CR632 and CR633, filtered by L632-C632, and then used to power the instrument and charge the batteries. Transistor Q634 is an error amplifier that regulates the battery charge current by providing a feedback signal through current-sensing resistor R632 back to the control winding of T623. This winding (pins 6 through 9), varies the frequency of the Power Inverter circuit. When the 221 is operated from the battery source, CR634 serves to connect the power to the instrument. When the 221 is connected to a power line, diode CR634 becomes reversed biased, which permits the error amplifier (Q634) to function. A start-up circuit consisting of CR622, C622, and R622 injects a signal into the base of Q626 to start-up the Line Inverter circuit. Diode CR621 serves to stop the free-running action of the start-up network.

The +5 V -5 V Regulator circuit derives its voltage from the Line Inverter circuit or the batteries, and regulates this voltage to 10 volts. Diodes CR654 and VR654 serve as the reference source, with Q648 functioning as a series-pass element. Transistors Q642 and Q644 operate as an error amplifier of the series-pass regulator circuit. Transistors Q640 and Q646 function as a protective circuit for the battery supply. When the battery voltage becomes lower than 10.3 volts, Q640 and Q646 are turned off, which turns off the entire power supply. This action prevents the complete discharge of the batteries whenever the battery charge becomes low.

Operational amplifier U654 is connected as a buffer amplifier providing a ground reference at the mid-point of the 10 volt supply, creating the +5 volt and the -5 volt supplies. Capacitors C656 and C657 provide filtering for the respective supply.

The Secondary Inverter circuit produces the +48 volt, +75 volt, approximately 600 volt peak-to-peak supply, and a 1.4 volt peak-to-peak crt heater supply. The +48 volt peak-to-peak supply is rectified and filtered by the network consisting of C712, CR712, CR713, and L713. The +75 volt peak-to-peak supply is rectified and filtered by the network consisting of C715, CR715, CR716, C714, and L716. Transistors Q666 and Q668 are connected as a free-running inverter, driving T701. Transistors Q660 and Q662, in conjunction with FET Q664, operate as a regulating circuit for the 1000 volt supply in the Secondary Inverter stage. When the 1000 volt supply is at a normal level, Q664 supplies the base drive to Q666 and Q668. When a change occurs in the 1000 volt supply, a difference is sensed by the gate of Q664 (through feedback resistor R667), which results in a re-adjustment of the base drive to Q666 and Q668. An adjustable current reference is also provided to Q664 through Q660 and Q662 by HIGH VOLTAGE adjustment R662.

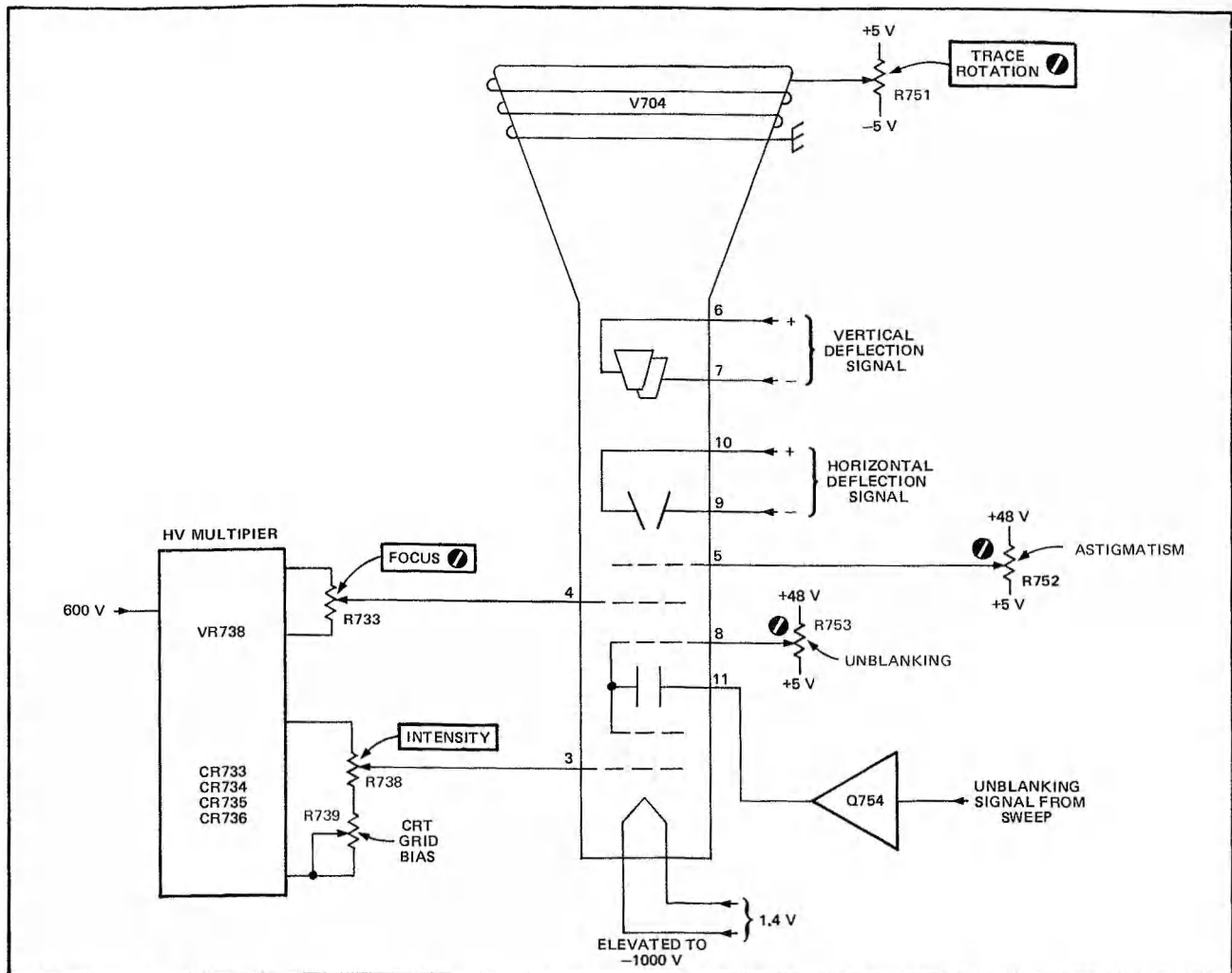


Fig. 4-5. Simplified block diagram of the CRT circuit.

CRT Circuit

The CRT circuit provides the high voltage and control circuits necessary for operation of the crt. A block diagram of the CRT circuit is shown in Fig. 4-5. A schematic is shown on diagram 5.

A network consisting of CR733, C733, CR734, C734, CR735, and CR736 is connected as a voltage doubler that provides approximately 1100 volts to the crt circuit. The 1100 volts is connected to a 110 V Zener diode VR738, which provides a 1000 volts supply to the Intensity circuit. It is further divided by R734 and R735 to provide the Focus control voltage. The 1000 volt supply is also returned to

the Secondary Inverter stage and serves as a reference for the regulating circuit.

Deflection plate blanking is used for controlling the crt beam. When an unblanking signal is received, Q754 turns on and forward biases CR756, which lowers the deflection blanking voltage to approximately 40 volts, which allows the electron beam to pass to the crt screen. The CRT GRID BIAS adjustment R739 controls the maximum usable intensity. The TRACE ROTATION adjustment R751 controls the current through L751, which affects both the vertical and horizontal rotation of the crt beam. FOCUS control R733, used in conjunction with ASTIGMATISM adjustment R752, is adjusted to obtain a well-defined display. UNBLANKING adjustment R753 is adjusted for optimum trace brightness.

CALIBRATION

TEKTRONIX FIELD SERVICE

Tektronix, Inc. provides complete instrument repair and recalibration at the Field Service Centers, and the Factory Service Center. Contact your local Tektronix Field Office or representative.

To assure instrument accuracy, check the calibration of the 221 every 1000 hours of operation, or every six months if used infrequently. Before calibrating the 221, thoroughly clean and inspect the instrument; see the maintenance section of this manual.

To aid in locating a step in this procedure, an index is given before the complete procedure. Where possible, the instrument performance is checked before an adjustment is made. For best overall instrument performance, make each adjustment to the exact setting even if the CHECK— step is within the allowable tolerance.

TEST EQUIPMENT REQUIRED

The following test equipment and accessories, or equivalent, are required for the complete calibration of the 221. The given specifications for the test equipment are the minimum necessary for accurate calibration. Therefore, the specifications of any test equipment used must meet or exceed the listed specifications. All the test equipment is assumed to be correctly calibrated and operating within the listed specification. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

Special Tektronix Calibration Fixtures are used in this procedure only where they facilitate instrument calibration. These calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Table 5-1
TEST EQUIPMENT REQUIRED

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
1. Constant Amplitude Signal Generator	50 kHz reference frequency; maximum frequency 6 MHz; variable amplitude.	Check horizontal, vertical and trigger bandwidth.	Tektronix Type 191 Constant Amplitude Signal Generator.
2. Standard Amplitude Calibrator	Amplitude accuracy: 0.25%, variable amplitude; 5 mV to 100 V; frequency: 1 kHz square wave.	Check horizontal and vertical gain.	Tektronix calibration fixture, Part Number 067-0502-01.
3. Square-wave Generator	Variable frequency: 10 Hz to 1 MHz; output amplitude: 400 mV to 80 V.	Check probe and vertical compensation.	Tektronix Type 106 Square-wave Generator.
4. 1:2 voltage step-up ¹ transformer	Double line voltage; 50 watt rating.	Check power supply and charger operation.	1:2 power transformer.
Variable Auto- ¹ transformer	Variable line voltage 90 V to 125 V.	Check power supply and charger operation.	Superior Electric Powerstat Type N10B.
5. Digital Multimeter	0.1% accuracy.	Check power supply and charger operation.	Tektronix DM 501 (Used with TM mainframe).
6. Time Mark Generator	0.1% accuracy.	Check horizontal timing.	Tektronix TG 501 (Used with TM mainframe).

¹ Both items can be replaced by a unit possessing the appropriate characteristics, such as General Radio W10MT3W. The Voltage step-up transformer is needed only when 230 VAC Line Voltage is not convenient.

Table 5-1 (cont)

TEST EQUIPMENT REQUIRED

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
7. Cable	Impedance, 50 ohms; type, RG-58/U; length, 42 inches, connectors, BNC.	External trigger operation check. Horizontal gain check and adjustment.	Tektronix Part Number 012-0057-01.
8. Adapter	Connectors, BNC female and dual banana plug.	External trigger checks.	Tektronix Part Number 103-0090-00.
9. Adapter	Connectors, GR874 and BNC female.	Vertical Amplifier compensation checks and adjustment.	Tektronix Part Number 017-0063-00.
10. Termination	Impedance, 50 ohms; accuracy, 2%, connectors, BNC.	Vertical Amplifier compensation checks and adjustment.	Tektronix Part Number 011-0049-01.
11. Attenuator	Ratio, 10X; connectors, BNC; impedance, 50 ohms.	Vertical Amplifier bandwidth check.	Tektronix Part Number 011-0059-02.
12. Adapter	Connectors, probe tip to BNC.	Used throughout procedure for signal interconnection.	Tektronix Part Number 013-0084-01.
13. T-Connector	Connectors, BNC.	External trigger operation checks.	Tektronix Part Number 103-0030-00.
14. Screwdriver	Three-inch shaft, 3/32 inch bit.	Used throughout procedure to adjust variable resistors.	Xcelite R-3323.
15. Low-Capacitance Screwdriver	3/4-inch shaft. 5/64 inch bit.	Used to adjust variable capacitors.	Tektronix Part Number 003-0675-00. J.F.D. Adjustment Tool 5284.

PRELIMINARY PROCEDURE

This instrument should be calibrated at an ambient temperature of +25°C (±5°C) for best overall accuracy.

1. Disassemble as instructed in the Maintenance Section.
2. Connect the instrument to 90 Vac, to 250 Vac, 48 Hz to 62 Hz or 80 Vdc to 250 Vdc line source.
3. Set the instrument controls as given in the Preliminary Control Settings. Allow at least five minutes of warmup before proceeding.

NOTE

Titles for external controls of this instrument are capitalized in the procedure (e.g., INTENSITY). Internal adjustments are initial capitalized only (e.g., Sweep Cal).

4. See the Adjustment Locations in the pullout pages.

PRELIMINARY CONTROL SETTINGS

Preset the instrument controls to the settings given below, when starting the calibration procedures.

VOLTS/DIV	0.1
SEC/DIV	1 m
Vertical POS	Midrange
Horizontal POS	Midrange
TRIGGER	Internal
TRIG LEVEL/SLOPE	AUTO PRESET
INPUT COUPLING	GND
HORIZ-MAG	1X
VAR SEC/DIV (Time/Div)	CAL
VAR VOLTS/DIV	CAL
INTENSITY	(Out of CCW Detent, ON) As desired.

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POWER SUPPLY

Equipment Required

- | | |
|------------------------------|----------------------------------|
| 1. Digital voltmeter | 3. 1:2 power step-up transformer |
| 2. Variable auto transformer | 4. Three-inch screwdriver |

Control Settings

Preset the controls as given in the Preliminary Control Setting.

1. Check/Adjust Low-voltage Supply

- a. Connect the digital voltmeter from the -5 volt test point to the $+5$ volt test point.
- b. Use the variable auto transformer and 1:2 power step-up transformer to provide a 90 to 250 Vac line source. Connect the 221 oscilloscope to the line.
- c. Check for a reading of 10 volts from a 90 to 250 Vac line.
- d. Adjust R644 Low Voltage adjustment for exactly 10 volts. See Fig. 5-1.
- e. Connect the common lead of the digital voltmeter to the 0 volt test point.
- f. Check the $+5$ volt supply for $+5$ volts ± 50 mV.

2. Check/Adjust High-voltage Supply

- a. Connect the digital voltmeter to the 1 kV test point.
- b. Check for a reading of -1000 volts.

- c. Adjust the High Voltage adjustment R662 for exactly -1000 volts. See Fig. 5-1.

3. Check/Adjust Grid Bias

- a. Connect the digital voltmeter to the 0.2 volt test point.
- b. Rotate the INTENSITY to the fully clockwise position.
- c. Check the digital voltmeter for a reading of 0.2 volt ± 0.02 volt.
- d. Adjust Grid Bias Adjustment R739 for exactly 0.2 volt. See Fig. 5-1.

4. Check +48-volt and +75-volt Supplies

- a. Connect the digital voltmeter from the 0 volt test point to the $+48$ -volt test point (leave INTENSITY fully clockwise for remainder of Step 4).
- b. Check for a minimum of $+48$ volts.
- c. Connect the digital voltmeter from the 0-volt test point to the $+75$ volt test point.
- d. Check for a minimum of $+75$ volts.
- e. Set INTENSITY as desired for normal viewing in Step 5.

5. Check Battery Charger Operation

a. Connect the common lead of the digital voltmeter to the second pin connector on the power supply board. Connect the other lead of the digital voltmeter to the BC test point. See Fig. 5-2.

b. Vary the line voltage from 90 to 250 Vac with the instrument on or off.

c. Check for a reading of +0.6 to +0.8 of a volt on the digital voltmeter.

d. Check for a 0 volt reading on the digital voltmeter, when the instrument is disconnected from the power line.

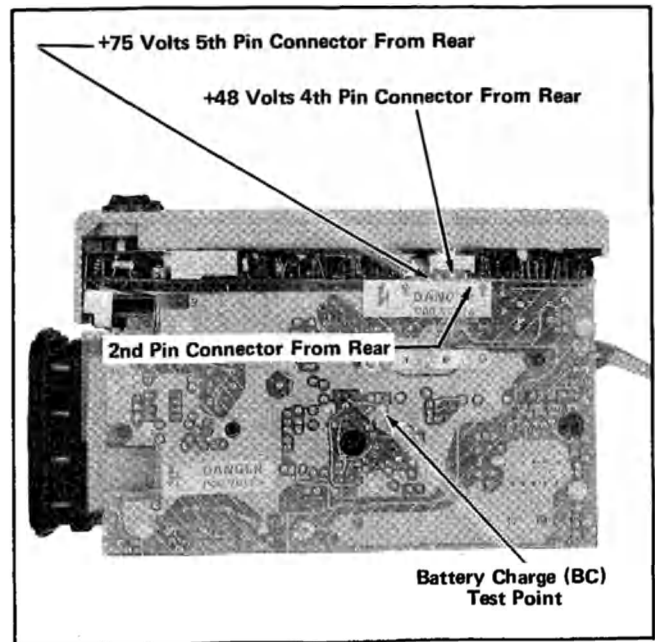


Fig. 5-2. Location of the +75 volt, +48 volt and the battery charger test points.

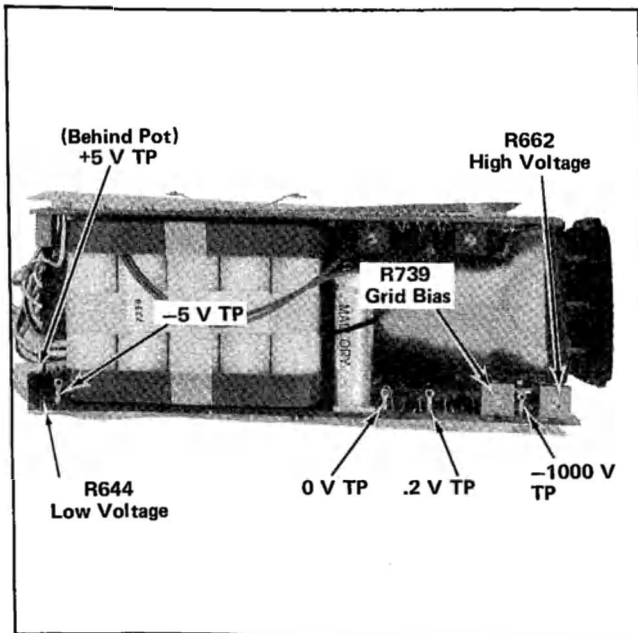


Fig. 5-1. Location of the Low Voltage, High Voltage adjustments and test points.

DISPLAY

Equipment Required

1. Time mark generator

2. Three-inch screwdriver

3. Adapter (probe tip to BNC)

Control Settings

Preset the controls as given in the Preliminary Control Setting. See Fig. 5-3 and Fig. 5-4 for locations of adjustment controls.

6. Check/Adjust Astigmatism and FOCUS

a. Set the SEC/DIV switch to the 1 V position (x-y mode).

b. Set the INTENSITY control for a small spot, near center of screen.

c. Check that the spot is round.

d. Adjust the FOCUS side panel screwdriver adjustment and the Astig. adjustment for a round spot.

7. Check/Adjust Trace Rotation

a. Set the SEC/DIV switch to 1 m.

b. Position the trace to the graticule center line.

c. Check that the trace is parallel to the center horizontal line.

d. Adjust Trace Rotation R751 (screwdriver adjustment on sidepanel) for a trace that is parallel with the horizontal graticule lines. See Fig. 5-4.

8. Check/Adjust CRT Unblanking

a. Set the INTENSITY to maximum, and set the SEC/DIV switch to 1 μ .

b. Adjust unblanking adjustment R753 (see Fig. 5-3) so that retrace is just blanked out.

9. Check Geometry

a. Preset the instrument controls as given in Preliminary Control Setting.

b. Set the SEC/DIV switch to the 1 millisecond position, and INPUT COUPLING to DC.

c. Connect the time mark generator to the probe by an adapter (probe to BNC). Set the markers for 1 millisecond.

d. Set the VOLTS/DIV switch setting for a full-screen deflection.

e. Check that vertical and horizontal bowing is less than 0.1 division.

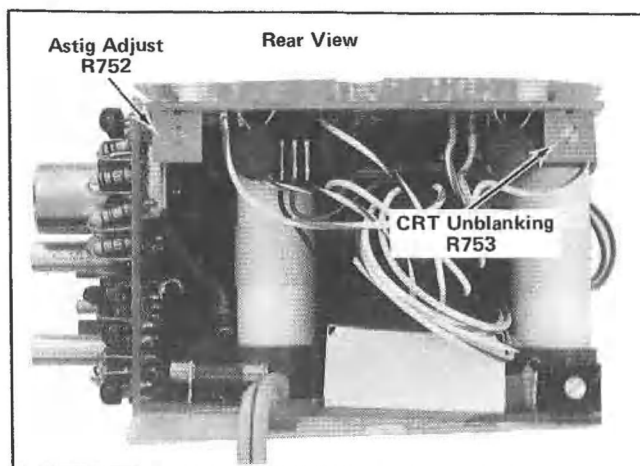


Fig. 5-3. Location of Astigmatism and CRT Unblanking adjustments.

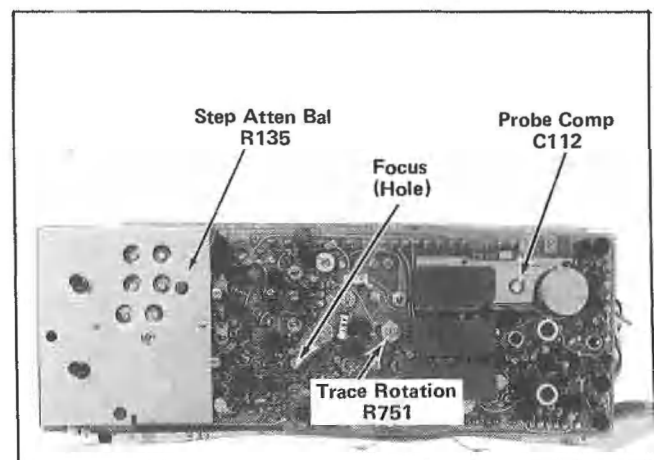


Fig. 5-4. Location of Step Attenuator Bal, Probe Compensation, and Focus adjustments.

VERTICAL SYSTEM

Equipment Required

- | | |
|--|--------------------------------|
| 1. Probe tip to BNC adapter | 4. Square-wave generator |
| 2. Standard amplitude calibrator | 5. Three-inch screwdriver |
| 3. Constant amplitude signal generator | 6. Low-capacitance screwdriver |

Control Settings

Preset the controls as given in the Preliminary Control Settings.

10. Check/Adjust Step Attenuator Balance (STEP BAL)

- a. Set the VOLTS/DIV switch to the 1 V position.
- b. Position the trace to the horizontal center line.
- c. Change the VOLTS/DIV switch to the 5 m position.
- d. Check that the trace is within 0.1 division of the center horizontal line.
- e. Adjust the STEP ATTEN BAL adjustment, R135, for a trace at the horizontal center line. See Fig. 5-4.
- f. Repeat part (a) through (e) until less than 0.1 division shift is noted when changing the VOLTS/DIV setting.

11. Check/Adjust VOLTS/DIV VAR BAL

- a. Set the trace to the center horizontal graticule line.
- b. Set the VOLTS/DIV setting to 0.1 and the VOLTS/DIV VAR to minimum counterclockwise direction.
- c. Check that there is less than 0.1 division of trace shift when varying the VOLTS/DIV VAR control.

- d. Adjust the VAR VOLTS/DIV BAL adjustment for a trace shift for no more than 0.1 division. See Fig. 5-5.

12. Check/Adjust Probe Compensation

- a. Set the VOLTS/DIV switch to .1, and INPUT COUPLING switch to DC.
- b. Connect the square-wave generator to the 221. Use a probe tip to BNC adapter, a 50-ohm termination, and a GR to BNC adapter.
- c. Set the square-wave generator for a 5 kHz signal with four divisions of display.
- d. Set the SEC/DIV switch to .1 m. Adjust the LEVEL/SLOPE control for a stable display, triggered on the positive excursion of the waveform.
- e. Check that the positive excursion of the displayed square wave is flat (flat top).
- f. Adjust C112 for the best square-wave display (flat top). See Fig. 5-4.
- g. Leave test equipment connected.

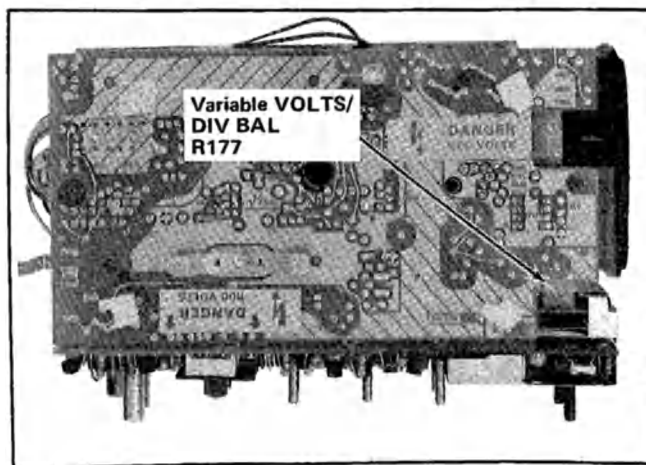


Fig. 5-5. Location of the VOLTS/DIV Var Bal adjustments.

13. Check/Adjust Attenuation Compensation

- a. Set the VOLTS/DIV switch to .2 and, set the SEC/DIV switch to .1 m. See Fig. 5-6 for location of attenuator adjustments.
- b. Adjust the output of the square-wave generator for a display of 4 divisions in amplitude.
- c. Check for a square wave that is flat (flat top).
- d. Adjust C122 for a square wave that is flat (flat top).
- e. Set the square-wave generator for 50 kHz.
- f. Set the SEC/DIV switch to 10 μ s.
- g. Check for a square wave that is flat.
- h. Adjust C120 for a square wave that is flat.
- i. Set the VOLTS/DIV switch to 2.
- j. Set the SEC/DIV switch to .1 m.
- k. Set the square-wave generator to 5 kHz and adjust the output for a four-division display.
- l. Check display for a flat square wave.
- m. Adjust C125 for a flat square wave.
- n. Set the square-wave generator for a 50-kHz signal.
- o. Set the SEC/DIV switch to 10 μ s.
- p. Check the display for a flat square wave.
- q. Adjust C123 for a flat square wave.
- r. Set the VOLTS/DIV switch to 20 and remove the 50 ohm termination.
- s. Set the output of the square-wave generator for a five kHz, four-division signal.
- t. Set the SEC/DIV switch to .1 m.

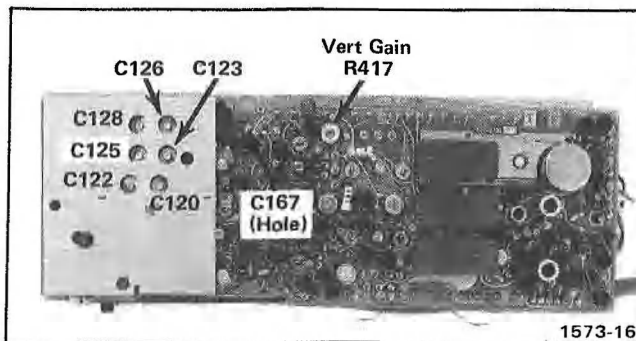


Fig. 5-6. Location of attenuator compensation and Vertical Gain adjustments.

- u. Check for a flat square wave.
- v. Adjust C128 for a flat square wave.
- w. Set the square-wave generator for a 50-kHz signal.
- x. Set the SEC/DIV switch to 10 μ s.
- y. Check for a flat square wave.
- z. Adjust C126 for a square wave that is flat.

14. Check/Adjust Vertical Gain

- a. Set the VOLTS/DIV switch to 50 m.
- b. Set the SEC/DIV switch to .2 m.
- c. Set INPUT COUPLING to DC.
- d. Connect the standard amplitude calibrator to the 221 oscilloscope. Use a probe tip to BNC adapter.
- e. Set the standard amplitude calibrator for a 0.2 volt signal.
- f. Check for a display of four divisions.
- g. Adjust R417 for a display of four divisions within 2%. See Fig. 5-6.
- h. Check all the VOLTS/DIV switch settings (see Table 5-2).

Table 5-2

VOLTS/DIV Setting	Standard Amplitude Calibration Setting	Number of Divisions
5 m	20 m Volts	4
10 m	50 m Volts	5
20 m	.1 Volt	5
50 m	.2 Volt	4
.1	.5 Volt	5
.2	1 Volt	5
.5	2 Volts	4
1	5 Volts	5
2	10 Volts	5
5	20 Volts	4
10	50 Volts	5
20	100 Volts	5
50	100 Volts	2
100	100 Volts	1

i. Rotate the VOLTS/DIV VAR control to the clockwise position.

j. Check that the display is less than 33% of the calibrated display. Return VOLTS/DIV VAR to the CAL detent.

15. Check/Adjust Vertical Step Response

- a. Set the VOLTS/DIV switch to .1.
- b. Set the SEC/DIV switch to 1 μ .
- c. Connect the fast-rise, positive output of the square-wave generator to the 221. Use a GR to BNC adapter, a 50-ohm termination and a probe tip to BNC adapter.
- d. Set the square-wave generator to 500 kHz. Adjust the square-wave generator output for a 5-division display.
- e. Set the HORIZ-MAG to 10X.
- f. Position the positive-going signal in the center of the graticule, with the top of the square wave visible.
- g. Adjust C432 (Bandwidth response) for the fastest rise time. See Fig. 5-7.
- h. Check aberrations for less than +5%, -5%, 5% peak to peak.
- i. Adjust C167 for a flat top with minimum aberrations (a slight readjustment of the C432 might be necessary for a flat top with no overshoot). See Fig. 5-6 and Fig. 5-7.

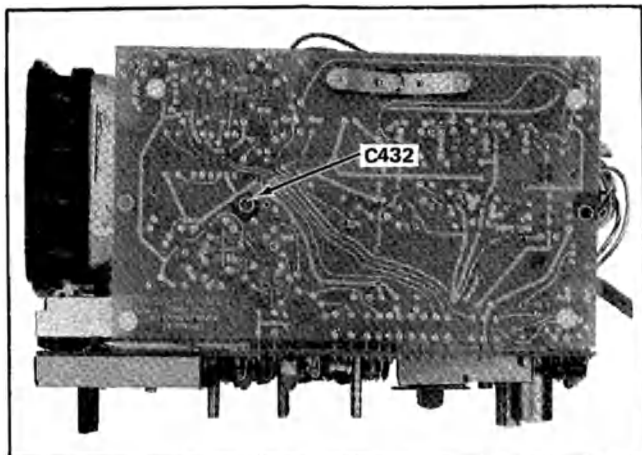


Fig. 5-7. Location of Bandwidth response adjustment.

16. Check/Adjust Vertical Bandwidth

- a. Set the VOLTS/DIV switch to .1, the SEC/DIV switch to 1 m and MAG to 1X.
- b. Connect the constant amplitude signal generator to the 221. Use a GR to BNC adapter, 50-ohm termination and a probe tip to BNC adapter.
- c. Set the constant amplitude signal generator to 50 kHz, and adjust the output amplitude of the constant amplitude signal generator for a deflection of six divisions.
- d. Adjust the frequency of the constant amplitude signal generator until 4.2 divisions of deflection are present on the crt screen.
- e. Check that the frequency of the constant amplitude signal generator is greater than 5 MHz.
- f. Adjust C432 for a deflection of at least 4.2 divisions at 5 MHz. Check display for a clean step response. See step 15.

17. Check Vertical Position Range

- a. Connect the constant amplitude signal generator to the 221 oscilloscope. Use a GR to BNC adapter and probe tip to BNC adapter.
- b. Set the VOLTS/DIV switch to .1.
- c. Set the constant amplitude signal generator to 50kHz reference, and adjust amplitude controls for a four-division display.
- d. Set the VOLTS/DIV to 20 m.
- e. Check that the bottom of the display can be positioned above the graticule center line and that the top of the display can be positioned below the graticule center line.

18. Check Input Noise

- a. Set the INPUT COUPLING switch to GND.
- b. Set the VOLTS/DIV switch to 5 m.

- c. Check noise on trace, for less than 0.1 division (adjust INTENSITY and FOCUS for a well-defined trace).

19. Check Gate Leakage

- a. Set the VOLTS/DIV switch to 5 m.
- b. Connect the probe, through a probe tip to BNC adapter, to a 50-ohm termination.
- c. Change INPUT COUPLING switch from GND to AC.
- d. Check for a trace shift of less than 0.1 division.

20. Check AC COUPLING

- a. Connect the 221 oscilloscope to the standard amplitude calibrator. Use a probe tip to BNC adapter and a 50-ohm BNC cable.
- b. Set the amplitude of the standard amplitude calibrator to 100 volts dc.
- c. Set the INPUT COUPLING switch to GND, and position the trace to center graticule line.
- d. Set the INPUT COUPLING switch to AC.
- e. Check that the display remains at graticule center line.

SWEEP TRIGGER

Equipment Required

- | | |
|--|---------------------------------|
| 1. Constant amplitude signal generator | 3. Cable, 50-ohm BNC connectors |
| 2. GR to BNC adapter | 4. T Connectors, BNC |
| | 5. Probe tip to BNC adapter |

Control Settings

Preset the controls as given in the Preliminary Control Settings.

21. Check Trigger Slope

a. Connect, to the constant amplitude signal generator, a GR to BNC adapter and a T connector. Use a probe tip to BNC adapter to connect the signal to the instrument. Connect the 50-ohm BNC cable to the T connector. Connect this cable to the EXT TRIG, using a dual banana plug adapter (GND on adapter to COMMON).

b. Set the INPUT COUPLING switch to DC.

c. Set the SEC/DIV switch to $5\ \mu$.

d. Set the frequency of the constant amplitude signal generator to 50 kHz.

e. Set the vertical deflection factor for a signal greater than 6 divisions.

f. Vary the LEVEL/SLOPE control to trigger on the positive slope of the display, then the negative slope.

g. Check that the display is triggered from the top graticule line to the bottom graticule line.

22. Check/Adjust Auto Preset Triggering

a. Set the VOLTS/DIV switch to .1.

b. Set the constant amplitude signal generator for a five-division display

c. Set the SEC/DIV to $50\ \mu$ and the LEVEL/SLOPE to AUTO-PRESET.

d. Set the VOLTS/DIV switch to 1.

e. Check that the display remains triggered (stable).

f. Adjust the AUTO PRESET (R214) side panel screw-driver adjustment for a triggered display. See Fig. 5-9.

g. Switch TRIGGER selector to EXT.

h. Check that the display is stable.

i. Set the SEC/DIV switch to $1\ \mu$.

j. Change frequency of constant amplitude signal generator to 5 MHz.

k. Check that the display remains stable (slight adjustment of AUTO PRESET adjustment of R214 may be necessary).

HORIZONTAL SYSTEM

Equipment Required

- | | |
|------------------------------------|----------------------------------|
| 1. BNC to dual banana plug adapter | 3. Three inch screwdriver |
| 2. Probe tip to BNC adapter | 4. Time mark generator |
| | 5. Standard amplitude calibrator |

Control Settings

Preset the controls as given in the Preliminary Control Settings.

23. Check/Adjust Horizontal Gain

- Preset the controls as given in the Preliminary Control Settings.
- Set the SEC/DIV switch to the 1 volt position.
- Connect the standard amplitude calibrator to the HORIZ INPUT. Use a BNC cable with a dual banana plug adapter (GND plug to COMMON).
- Set the standard amplitude calibrator amplitude for a 5 volt signal.
- Check for a five-division display.

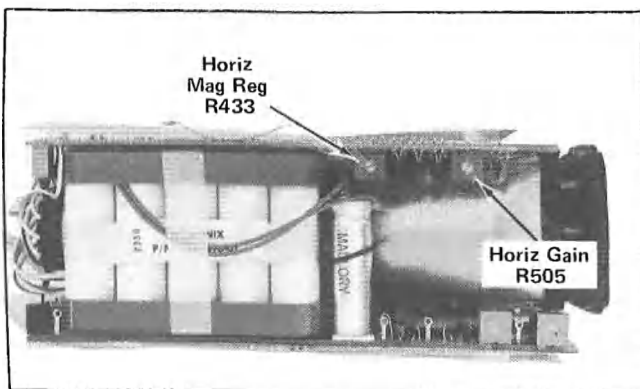


Fig. 5-8. Location of Horizontal Gain and Magnifier Registration adjustments.

- Adjust Horizontal Gain adjustment R505 for a five-division display. See Fig. 5-8.

- Disconnect all the test equipment.

24. Check/Adjust Horizontal Magnifier Registration

- Position the spot to the center of the crt graticule.
- Set the HORIZ-MAG switch to the 10X position.
- Check that the spot remains within one division of graticule center.
- Adjust the Mag Regis adjustment R433 for less than one division shift from the 1X to the 10X position. See Fig. 5-8.

25. Check Horizontal Bandwidth

- Set the SEC/DIV switch to 1 V.
- Set INPUT COUPLING to GND.
- Connect the constant amplitude signal generator to the HORIZ INPUT jack. Use a dual banana plug to BNC adapter (GND adapter to COMMON), a 50-ohm cable and a GR to BNC adapter.
- Set the constant amplitude signal generator to 50-kHz reference. Adjust the output of the constant amplitude signal generator for six divisions of horizontal display.

e. Increase the frequency of the constant amplitude signal generator to 500 kHz without changing the signal amplitude.

f. Check for a display greater than 4.2 divisions.

g. Set the HORIZ-MAG switch 10X and repeat steps d through f.

26. Check/Adjust Sweep Cal (Timing)

a. Set the HORIZ MAG to 1X.

b. Set the INPUT COUPLING to DC.

c. Connect the probe to the output of the time mark generator (TG 501) using a probe tip to BNC adapter and a 50-ohm termination.

d. Set the SEC/DIV switch to 2 m.

e. Set the time mark generator (TG 501) for 2 milli-second time marks.

f. Check that the time marks align with the graticule lines over the center eight divisions.

g. Adjust the SWP CAL adjustment R354 so that the time marks align with the center eight graticule lines. See Fig. 5-9.

h. Check all other ranges of timing within 3%. Use appropriate settings on the time mark generator.

i. Set the SEC/DIV to 1 μ s.

j. Set the time mark generator for 1 μ s time marks.

k. Check that the time marks align with the graticule (disregard the first 0.5 μ s of the display).

l. Adjust C354 so that the time marks align with the center eight graticule lines. See Fig. 5-9.

m. Set HORIZ MAG to 10X.

n. Set time mark generator for 1 μ s time marks.

o. Check that the time marks align with the center eight divisions of the graticule within 5% (disregard first .5 μ s of sweep).

27. Check Horizontal Position Range

a. Set the HORIZ MAG switch to 10X.

b. Check that the right and left ends of trace can be positioned to center of screen.

c. Disconnect all test equipment.

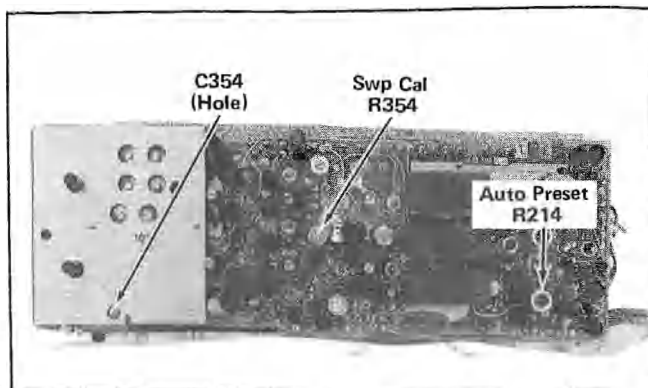


Fig. 5-9. Location of Sweep Cal and Auto Preset adjustments.

TROUBLESHOOTING AIDS

Diagrams

Complete circuit diagrams are given in the rear of this manual. The component number and electrical value of each component in this instrument both appear on the diagrams. The portions of the circuit that are mounted on circuit boards are enclosed with lines.

Figure 6-1 shows the location of the circuit boards within the instrument along with their assembly (A) numbers. The assembly numbers are also used on the diagrams to aid in locating the boards. Circuit board layouts are shown in the Diagrams section, on the back of the page opposite the circuit diagram, to aid in cross-referencing between the diagrams and the circuit board. Each electrical component on the boards is identified by its circuit number. The components are listed in the table near the circuit board layouts. To find a component, locate it in the component list, and note the coordinates listed with it. Locate the coordinates on the layout, and the component is located within this area.

Troubleshooting Equipment

The majority of troubleshooting to be done on the 221 can be accomplished with a 20,000 ohms/volt VOM such as a Triplet Model 230-NA or a Simpson Model 262. Use a dynamic semiconductor tester, such as a Tektronix Type 577 Curve Tracer system, to check the semiconductors used in the 221. To check waveforms in this instrument, use a test oscilloscope with a dc to five megahertz frequency response and one millivolt to 50 volts/division deflection factor.

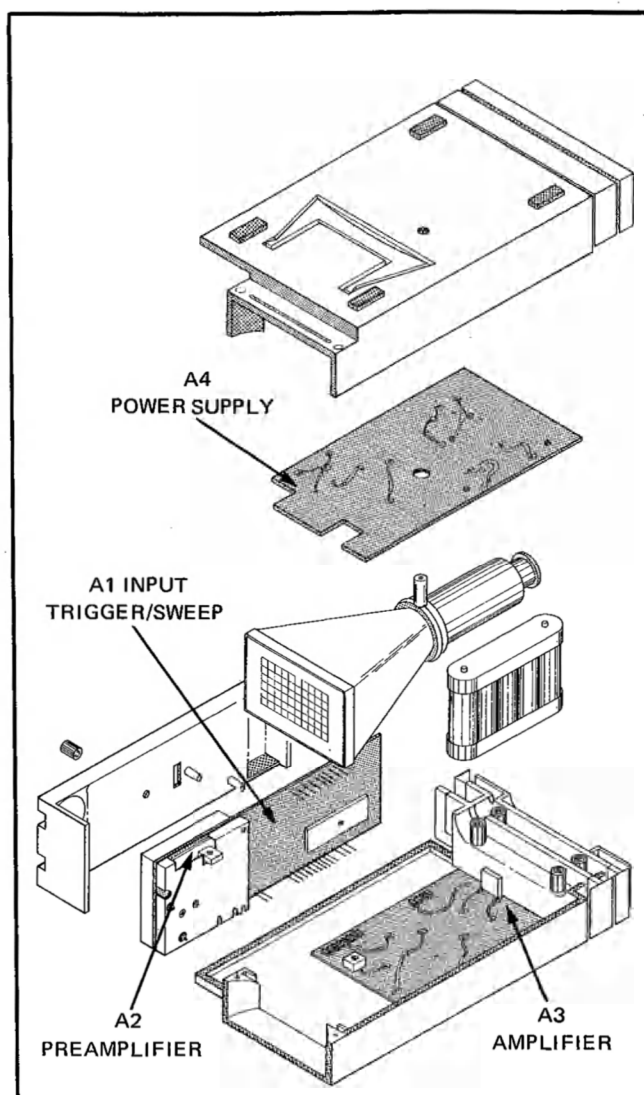


Fig. 6-1. Location of circuit boards in the 221 Oscilloscope.

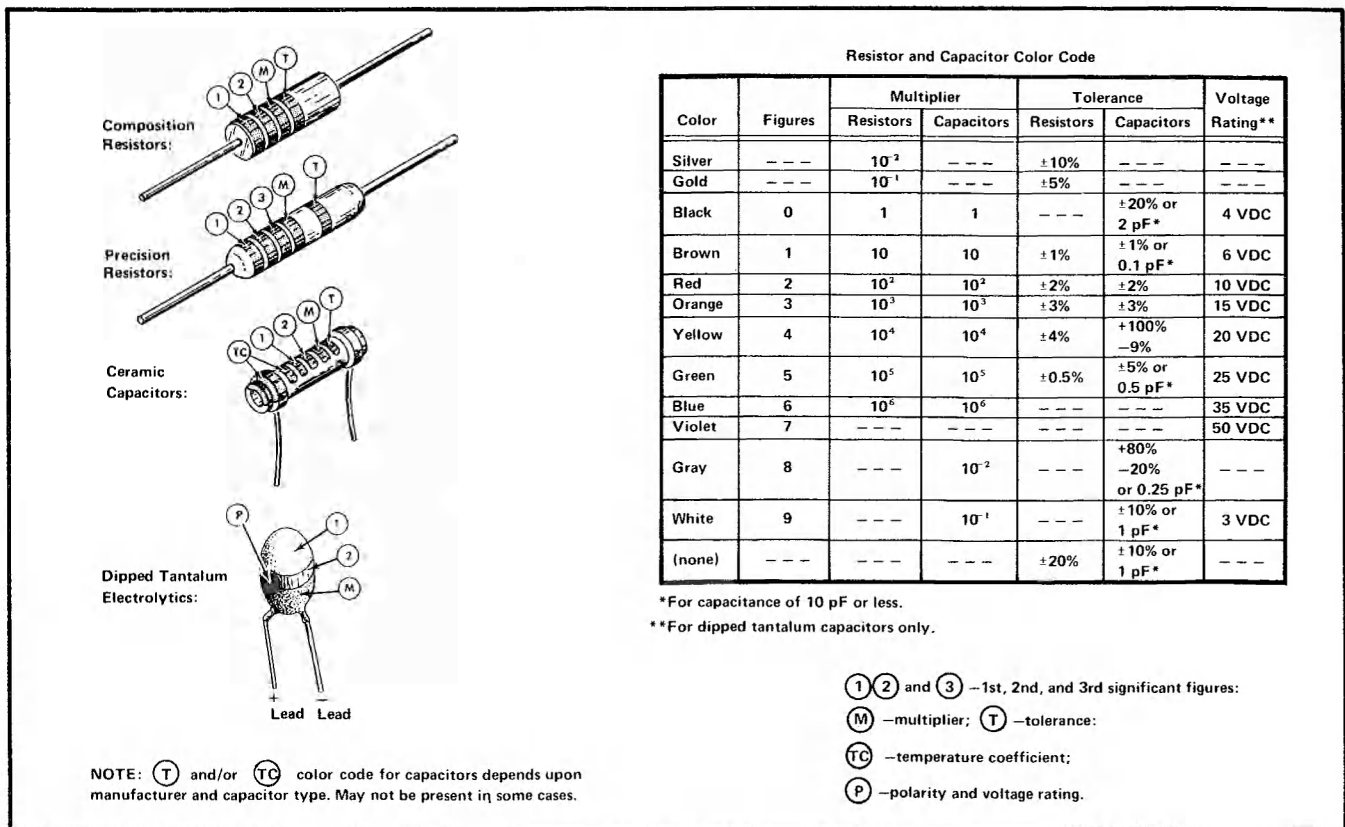


Fig. 6-2. Color code for resistors, ceramic capacitors, and dip tantalum electrolytic capacitors.

Component Color Coding

The resistors used in the 221 are either composition resistors or precision resistors. The resistance values are color-coded on the components with EIA color-code (some precision resistors may have the value printed on the body). The color-code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes that consist of two significant figures, a multiplier, and a tolerance value (see Fig. 6-2). Precision resistors have five stripes consisting of three significant figures, a multiplier, and a tolerance value.

The capacitance value of common disc capacitors and small tubular electrolytics is marked in microfarads on the side of the component body. The molded electrolytic capacitors are color-coded in picofarads (see Fig. 6-2).

The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot.

Isolating Trouble To A Circuit

To isolate the trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. For example, no intensity indicates that the crt circuit is probably at fault. When trouble symptoms appear, check the circuit by taking voltage and waveform measurements. Typical voltages and waveforms are shown on the schematics in the diagram section of this manual. Figure 6-3 provides a guide for locating a defective circuit.

Start from the top of the chart and perform the given checks on the left side of the page. When a check is performed that does not produce the indicated results, further checks and/or circuits in which the trouble is probably located are listed to the right of this step. After the defective circuit has been located, proceed to locate the defective component(s).

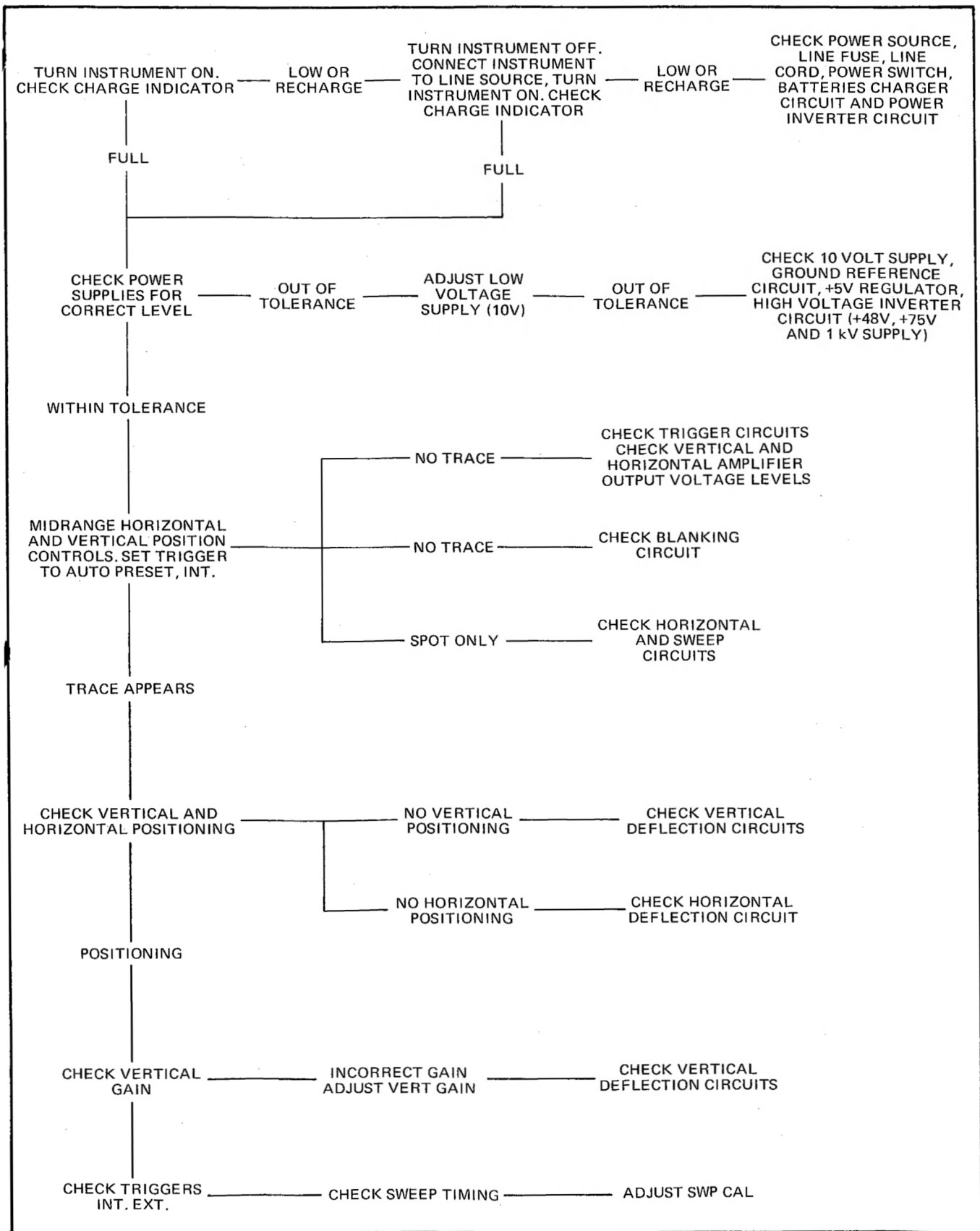


Fig. 6-3. Circuit Isolation Troubleshooting Chart.

CORRECTIVE MAINTENANCE

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the 221 can be obtained through your local Tektronix Field Office or representative. Many of the standard electronic components, however, can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE

When selecting replacement parts, remember that the physical size and shape of a component may affect its performance in the instrument. All replacement parts should be a direct replacement unless a different component is known to not adversely affect the instrument's performance.

Special parts. In addition to the standard electronic components, some special components are used in the 221. These components are manufactured or selected by Tektronix, Inc. to meet specific requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts. When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.
2. Instrument serial number.
3. A description of the part (if electrical, include circuit number).
4. Tektronix Part Number.

Component Replacement

Disassembly. To gain access to the interior of the instrument, unwind both the power cord and the attached probe cord from the rear of the instrument. Remove the five screws in the bottom cover of the instrument. See Fig. 7-1. Gently separate the bottom cover from the instrument and lay aside. The Power Supply circuit board with the batteries can be lifted up and pivoted out of the way. Most of the internal workings of the instrument are now accessible.

If it is necessary to have access to the front of the Input circuit board, remove the knobs from all of the external control shafts. Remove the two screws securing the instrument side panel to the Input circuit board and remove the instrument side panel.

WARNING

Disconnect the instrument from any external power source before replacing components.

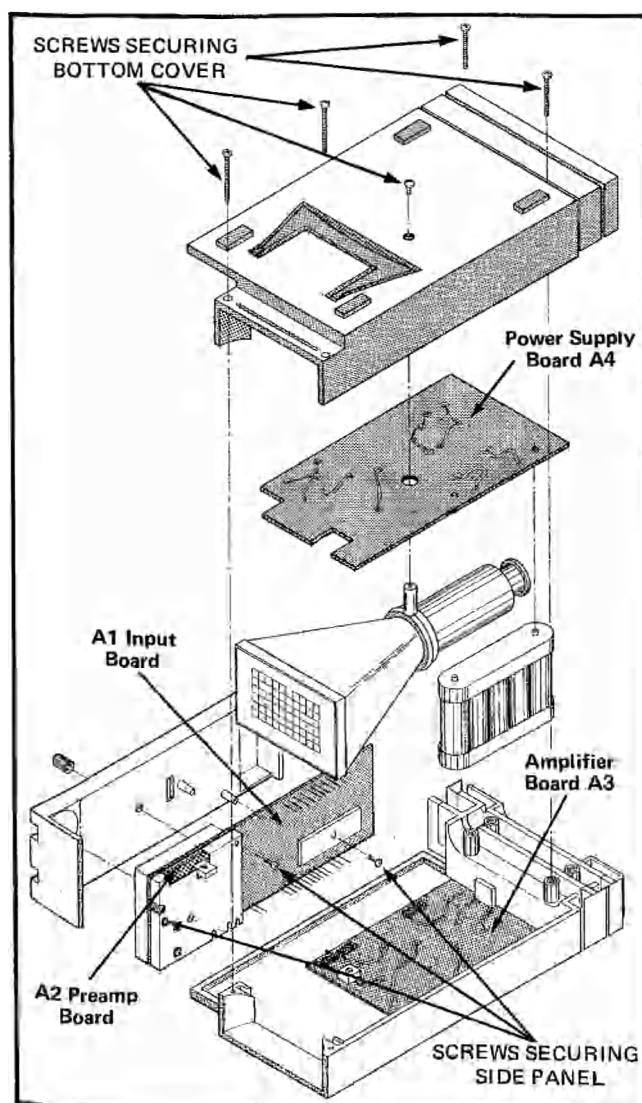


Fig. 7-1. Location of circuit boards and securing screws.

Circuit Board Replacement. If a circuit board is damaged beyond repair, the entire assembly including all soldered on components can be replaced. Part numbers are given in the Mechanical Parts List for either the completely wired or the unwired board.

NOTE

Even though unwired boards are available without components, use of the completely wired replacement board is recommended due to the large number of components mounted on most of the boards.

Transistor Replacement. Transistors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of transistors may affect the calibration of this instrument. When transistors are replaced, check the operation of that part of the instrument which may be affected.

Replacement transistors should be of the original type or a direct replacement. Fig. 3-2 shows the lead configuration of the transistors used in this instrument. Some plastic case transistors have lead configurations which do not agree with those shown here. If a transistor is replaced by a transistor which is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the basing used for metal-case transistors.

Rotary Switches. Individual parts of the VOLTS/DIV and SEC/DIV rotary switches are replaceable. Refer to the Parts List for the applicable part numbers for replacement parts.

Troubleshooting Aids

Circuit board extenders are available to allow troubleshooting boards with power applied. Order Tektronix Part No. 067-0760-00 for Power Supply board extender, and 067-0761-00 for Amplifier board extender.

Recalibration After Repair

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. Since the power supply affects all circuits, calibration of the entire instrument should be checked if work has been done in the supply.

REPACKAGING FOR SHIPMENT

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted, complete instrument serial number and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Refer to the following table for carton test strength requirements.
2. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.
4. Seal carton with shipping tape or industrial stapler.

SHIPPING CARTON TEST STRENGTH

Gross Weight (lb)	Carton Test Strength (lb)
0-10	200
10-30	275
30-120	375
120-140	500
140-160	600

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
14552	MICRO SEMICONDUCTOR CORP.	2830 F FAIRVIEW ST.	SANTA ANA, CA 92704
14936	GENERAL INSTRUMENT CORP., SEMICONDUCTOR PRODUCTS GROUP	P.O. BOX 600, 600 W. JOHN ST.	HICKSVILLE, NY 11802
19396	ILLINOIS TOOL WORKS, INC. PAKTRON DIV.	900 FOLLIN LANE, SE	VIENNA, VA 22180
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
51642	CENTRE ENGINEERING INC.	2820 E COLLEGE AVENUE	STATE COLLEGE, PA 16801
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71450	CTS CORP.	905 N. WEST BLVD	ELKHART, IN 46514
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE., P O BOX 5825	COMPTON, CA 90224
78488	STACKPOLE CARBON CO.		ST. MARYS, PA 15857
79727	C-W INDUSTRIES	550 DAVISVILLE RD., P O BOX 96	WARMINSTER, PA 18974
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80031	ELECTRA-MIDLAND CORP., MEPCO DIV.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET	
		P. O. BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-2791-00	B010100	B020517	CKT BOARD ASSY:--INPUT	80009	670-2791-00
A1	670-2791-01	B020518	B022748	CKT BOARD ASSY:--INPUT	80009	670-2791-01
A1	670-2791-02	B022749	B054450	CKT BOARD ASSY:--INPUT	80009	670-2791-02
A1	670-2791-03	B054451		CKT BOARD ASSY:--INPUT	80009	670-2791-03
A2	670-2792-00			CKT BOARD ASSY:--PREAMPLIFIER	80009	670-2792-00
A3	670-2793-00	B010100	B029999	CKT BOARD ASSY:--AMPLIFIER	80009	670-2793-00
A3	670-2793-01	B030000	B054450	CKT BOARD ASSY:--AMPLIFIER	80009	670-2793-01
A3	670-2793-02	B054451		CKT BOARD ASSY:--AMPLIFIER	80009	670-2793-02
A4	670-2794-00	B010100	B020806	CKT BOARD ASSY:--POWER SUPPLY	80009	670-2794-00
A4	670-2794-01	B020807	B039999	CKT BOARD ASSY:--POWER SUPPLY	80009	670-2794-01
A4	670-2794-03	B040000		CKT BOARD ASSY:--POWER SUPPLY	80009	670-2794-03
BT632	146-0034-00	B010100	B023549	BATTERY ASSY:2 SETS OF 5	80009	146-0034-00
BT633	146-0034-00	B010100	B023549	BATTERY ASSY:2 SETS OF 5	80009	146-0034-00
	-----			(BT632, BT633, SEE MECHANICAL PARTS LIST FOR SUB-PARTS)		
BT632	146-0033-00	B023550		BATTERY ASSY:2 SETS OF 5	80009	146-0033-00
BT633	146-0033-00	B023550		BATTERY ASSY:2 SETS OF 5	80009	146-0033-00
	-----			(BT632, BT633, SEE MECHANICAL PARTS LIST FOR SUB-PARTS)		
C100	285-0697-06	B010100	B023548X	CAP., FXD, PLSTC:0.1UF, +5-15%, 600V	80009	285-0697-06
C112	281-0167-00			CAP., VAR, CER DI:9-45PF, 200V	72982	538-011-D 9-45
C120	281-0178-00			CAP., VAR, PLSTC:1-3.5PF, 500V	80031	2805D013R5BH02F0
C121	283-0637-00			CAP., FXD, MICA D:20PF, 2.5%, 100V	00853	D151E200D0
C122	281-0182-00			CAP., VAR, PLSTC:1.8-10PF, 500V	80031	2805D1R810BH02F0
C123	281-0178-00			CAP., VAR, PLSTC:1-3.5PF, 500V	80031	2805D013R5BH02F0
C124	283-0598-00			CAP., FXD, MICA D:253PF, 5%, 300V	00853	D153E2530J0
C125	281-0182-00			CAP., VAR, PLSTC:1.8-10PF, 500V	80031	2805D1R810BH02F0
C126	281-0178-00			CAP., VAR, PLSTC:1-3.5PF, 500V	80031	2805D013R5BH02F0
C127	283-0729-00			CAP., FXD, MICA D:2500PF, 5%, 500V	00853	D19-5E252J0
C128	281-0182-00			CAP., VAR, PLSTC:1.8-10PF, 500V	80031	2805D1R810BH02F0
C133	283-0204-00			CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N06125U0103M
C164	283-0095-00			CAP., FXD, CER DI:56PF, 10%, 200V	72982	855-535A560K
C167	281-0182-00			CAP., VAR, PLSTC:1.8-10PF, 500V	80031	2805D1R810BH02F0
C175	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C192	290-0530-00			CAP., FXD, ELCTLT:68UF, 20%, 6V	90201	TDC686M006NLF
C194	290-0530-00			CAP., FXD, ELCTLT:68UF, 20%, 6V	90201	TDC686M006NLF
C218	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C227	283-0204-00			CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N06125U0103M
C232	283-0643-00			CAP., FXD, MICA D:22PF, +/-0.5PF, 300V	00853	D105C220D
C233	283-0644-00			CAP., FXD, MICA D:150PF, 1%, 500V	00853	D155E151F0
C234	281-0557-00	B010100	B021517	CAP., FXD, CER DI:1.8PF, 10%, 500V	72982	301-000C0K0189B
C234	281-0604-00	B020518		CAP., FXD, CER DI:2.2PF, +/-0.25PF, 500V	72982	301-000C0J0229C
C235	283-0204-00			CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N06125U0103M
C252	283-0156-00	B010100	B010579	CAP., FXD, CER DI:1000PF, +100-0%, 200V	72982	8111A208Z5U0102Z
C252	283-0108-00	B010580		CAP., FXD, CER DI:220PF, 10%, 200V	56289	272C13
C256	290-0534-00			CAP., FXD, ELCTLT:1UF, 20%, 35V	56289	196D105X0035HA1
C314	281-0634-00			CAP., FXD, CER DI:10PF, +/-0.25PF, 500V	72982	374011C0G100C
C316	283-0156-00			CAP., FXD, CER DI:1000PF, +100-0%, 200V	72982	8111A208Z5U0102Z
C324	283-0168-00			CAP., FXD, CER DI:12PF, 5%, 100V	72982	8101B121C0G0120J
C325	283-0047-00			CAP., FXD, CER DI:270PF, 5%, 500V	72982	0831522Z5D00271J
C326	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C327	285-0862-00			CAP., FXD, PLSTC:0.001, 10%, 100V	56289	410P10291
C333	283-0047-00			CAP., FXD, CER DI:270PF, 5%, 500V	72982	0831522Z5D00271J
C337	283-0204-00			CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N06125U0103M
C344	283-0251-00			CAP., FXD, CER DI:87 PF, 5%, 100V	72982	8121B145C0G0870J

Replaceable Electrical Parts—221 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C351}	295-0169-00			CAP., SET, MTCHD: 1UF, 0.01UF, 0.001UF, MTCHD 1% (C351 THRU C353, INDIVIDUAL TIMING	80009	295-0169-00
C352}				CAPACITORS IN THIS ASSEMBLY MUST BE ORDERED		
C353}				BY THE 9-DIGIT PART NUMBER, LETTER SUFFIX AND		
				TOLERANCE PRINTED ON THE TIMING CAPACITOR TO		
				BE REPLACED. THE LETTER SUFFIX AND TOLERANCE		
				SHOULD BE THE SAME FOR ALL THE TIMING		
				CAPACITORS IN THE ASSEMBLY.		
				EXAMPLE: 285-XXXX-XX F-)		
C354	281-0161-00			CAP., VAR, CER DI: 5-15PF, 350V	72982	518-000A5-15
C355	283-0674-00			CAP., FXD, MICA D: 85PF, 1%, 500V	00853	D155F850F0
C356	281-0615-00			CAP., FXD, CER DI: 3.9PF, +/-0.5PF, 200V	72982	374001C0J0399D
C362	290-0535-00			CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
C363	290-0535-00			CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
C364	290-0535-00			CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
C365	290-0535-00			CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
C417	281-0618-00			CAP., FXD, CER DI: 4.7PF, +/-0.5PF, 200V	72982	374001C0H0479D
C422	283-0095-00			CAP., FXD, CER DI: 56PF, 10%, 200V	72982	855-535A560K
C423	283-0003-00			CAP., FXD, CER DI: 0.01UF, +/-0.2%, 150V	72982	855-558Z5U-103Z
C432	281-0212-00	B010100	B044174	CAP., VAR, PLSTC: 1.5-5.5PF, 100V	80031	2807C1R406MM02F
C432	281-0202-00	B044175		CAP., VAR, PLSTC: 1.5-5.5PF, 100V	80031	2807C1R406MM02F
C433	283-0000-00			CAP., FXD, CER DI: 0.001UF, +/-100-0%, 500V	72982	831-516E102P
C435	283-0003-00			CAP., FXD, CER DI: 0.01UF, +/-80-20%, 150V	72982	855-558Z5U-103Z
C436	283-0024-00			CAP., FXD, CER DI: 0.1UF, +/-80-20%, 50V	72982	8121N083Z5U0104Z
C447	283-0003-00			CAP., FXD, CER DI: 0.01UF, +/-80-20%, 150V	72982	855-558Z5U-103Z
C456	283-0348-00			CAP., FXD, CER DI: 0.5PF, +/-0.1PF, 100V	51642	100-100-NP0-508B
C458	290-0525-00			CAP., FXD, ELCTLT: 4.7UF, 20%, 50V	56289	196D475X0050KA1
C462	283-0024-00			CAP., FXD, CER DI: 0.1UF, +/-80-20%, 50V	72982	8121N083Z5U0104Z
C466	283-0348-00			CAP., FXD, CER DI: 0.5PF, +/-0.1PF, 100V	51642	100-100-NP0-508B
C512	283-0003-00			CAP., FXD, CER DI: 0.01UF, +/-80-20%, 150V	72982	855-558Z5U-103Z
C516	290-0530-00			CAP., FXD, ELCTLT: 68UF, 20%, 6V	90201	TDC686M006NLF
C517	283-0003-00			CAP., FXD, CER DI: 0.01UF, +/-80-20%, 150V	72982	855-558Z5U-103Z
C523	290-0530-00			CAP., FXD, ELCTLT: 68UF, 20%, 6V	90201	TDC686M006NLF
C534	290-0517-00			CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	196D685X0035KA1
C535	283-0024-00			CAP., FXD, CER DI: 0.1UF, +/-80-20%, 50V	72982	8121N083Z5U0104Z
C542	283-0110-00			CAP., FXD, CER DI: 0.005UF, +/-80-20%, 150V	56289	19C242B
C544	283-0110-00			CAP., FXD, CER DI: 0.005UF, +/-80-20%, 150V	56289	19C242B
C545	283-0348-00			CAP., FXD, CER DI: 0.5PF, +/-0.1PF, 100V	51642	100-100-NP0-508B
C548	283-0317-00			CAP., FXD, CER DI: 1PF, +/-0.1PF, 500V	72982	861-518-C0K0109B
C556	283-0317-00			CAP., FXD, CER DI: 1PF, +/-0.1PF, 500V	72982	861-518-C0K0109B
C557	290-0525-00			CAP., FXD, ELCTLT: 4.7UF, 20%, 50V	56289	196D475X0050KA1
C571	290-0530-00			CAP., FXD, ELCTLT: 68UF, 20%, 6V	90201	TDC686M006NLF
C572	283-0024-00			CAP., FXD, CER DI: 0.1UF, +/-80-20%, 50V	72982	8121N083Z5U0104Z
C573	290-0530-00			CAP., FXD, ELCTLT: 68UF, 20%, 6V	90201	TDC686M006NLF
C612	283-0002-00			CAP., FXD, CER DI: 0.01UF, +/-80-20%, 500V	72982	811-546E103Z
C613	283-0279-00			CAP., FXD, CER DI: 0.001UF, 20%, 3000V	56289	55C153
C614	283-0279-00			CAP., FXD, CER DI: 0.001UF, 20%, 3000V	56289	55C153
C615	283-0002-00			CAP., FXD, CER DI: 0.01UF, +/-80-20%, 500V	72982	811-546E103Z
C616	283-0000-00			CAP., FXD, CER DI: 0.001UF, +/-100-0%, 500V	72982	831-516E102P
C617	290-0652-00			CAP., FXD, ELCTLT: 5UF, +/-50-10%, 450V	56289	30D501
C618	283-0008-00	XB020680		CAP., FXD, CER DI: 0.1UF, 20%, 500V	56289	275C8
C622	283-0156-00	B010100	B020806	CAP., FXD, CER DI: 1000PF, +/-100-0%, 200V	72982	811A208Z5U0102Z
C622	283-0204-00	B020807		CAP., FXD, CER DI: 0.01UF, 20%, 50V	72982	8121N061Z5U0103M
C623	283-0627-00	B010100	B020806	CAP., FXD, MICA D: 0.0033UF, 5%, 500V	00853	D195E332J0
C623	285-1095-00	B020807		CAP., FXD, PLSTC: 3300PF, 10%, 400V	19396	332K06PP481
C632	290-0519-00			CAP., FXD, ELCTLT: 100UF, 20%, 20V	90201	TDC107M020WLD
C633	283-0204-00	XB020680		CAP., FXD, CER DI: 0.01UF, 20%, 50V	72982	8121N061Z5U0103M
C634	290-0535-00	B010100	B039999	CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
C634	290-0519-00	B040000		CAP., FXD, ELCTLT: 100UF, 20%, 20V	90201	TDC107M020WLD
C644	290-0534-00			CAP., FXD, ELCTLT: 1UF, 20%, 35V	56289	196D105X0035HA1
C647	290-0524-00			CAP., FXD, ELCTLT: 4.7UF, 20%, 10V	90201	TDC475M010EL
C656	290-0535-00			CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
C657	290-0535-00			CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
C662	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C663	283-0104-00			CAP., FXD, CER DI: 2000PF, 5%, 500V	72982	811-565B202J
C666	290-0574-00			CAP., FXD, ELCTLT: 47UF, 10%, 20V	90201	TDC476K020CL
C667	283-0156-00	XB020680		CAP., FXD, CER DI: 1000PF, +100-0%, 200V	72982	8111A208Z5U0102Z
C668	283-0087-00			CAP., FXD, CER DI: 300PF, 10%, 1000V	56289	403637
C712	290-0525-00			CAP., FXD, ELCTLT: 4.7UF, 20%, 50V	56289	196D475X0050KA1
C713	290-0525-00			CAP., FXD, ELCTLT: 4.7UF, 20%, 50V	56289	196D475X0050KA1
C714	290-0525-00			CAP., FXD, ELCTLT: 4.7UF, 20%, 50V	56289	196D475X0050KA1
C715	290-0525-00			CAP., FXD, ELCTLT: 4.7UF, 20%, 50V	56289	196D475X0050KA1
C731	290-0534-00			CAP., FXD, ELCTLT: 1UF, 20%, 35V	56289	196D105X0035HA1
C732	283-0002-00			CAP., FXD, CER DI: 0.01UF, +80-20%, 500V	72982	811-546E103Z
C733	283-0013-00			CAP., FXD, CER DI: 0.01UF, +100-0%, 1000V	56289	33C29A7
C734	283-0013-00			CAP., FXD, CER DI: 0.01UF, +100-0%, 1000V	56289	33C29A7
C735	283-0013-00			CAP., FXD, CER DI: 0.01UF, +100-0%, 1000V	56289	33C29A7
C736	283-0002-00			CAP., FXD, CER DI: 0.01UF, +80-20%, 500V	72982	811-546E103Z
C737	283-0005-00	B010100	B020679	CAP., FXD, CER DI: 0.01UF, +100-0%, 250V	72982	8131N300Z5U0103P
C737	283-0002-00	B020680		CAP., FXD, CER DI: 0.01UF, +80-20%, 500V	72982	811-546E103Z
C738	283-0005-00	B010100	B020679	CAP., FXD, CER DI: 0.01UF, +100-0%, 250V	72982	8131N300Z5U0103P
C738	283-0002-00	B020680		CAP., FXD, CER DI: 0.01UF, +80-20%, 500V	72982	811-546E103Z
C739	283-0022-00			CAP., FXD, CER DI: 0.02UF, 1400VDCAC	80009	283-0022-00
C752	283-0003-00			CAP., FXD, CER DI: 0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
C753	283-0003-00			CAP., FXD, CER DI: 0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
CR132	152-0246-00			SEMICONV DEVICE: SILICON, 40V, 200MA	80009	152-0246-00
CR137	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR162	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR165	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR175	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR176	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR215	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR228	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR232	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR317	152-0181-00			SEMICONV DEVICE: GERMANIUM, 1MA, 5PF	80009	152-0181-00
CR318	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR328	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR345	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR422	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR423	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR434	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR435	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR453	152-0322-00			SEMICONV DEVICE: SILICON, 15V, HOT CARRIER	80009	152-0322-00
CR454	152-0322-00			SEMICONV DEVICE: SILICON, 15V, HOT CARRIER	80009	152-0322-00
CR455	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR462	152-0322-00			SEMICONV DEVICE: SILICON, 15V, HOT CARRIER	80009	152-0322-00
CR467	152-0322-00			SEMICONV DEVICE: SILICON, 15V, HOT CARRIER	80009	152-0322-00
CR468	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR469	152-0333-00	XB030000		SEMICONV DEVICE: SILICON, 55V, 200MA	80009	152-0333-00
CR470	152-0333-00	XB030000		SEMICONV DEVICE: SILICON, 55V, 200MA	80009	152-0333-00
CR522	152-0322-00			SEMICONV DEVICE: SILICON, 15V, HOT CARRIER	80009	152-0322-00
CR525	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR532	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR533	152-0141-02			SEMICONV DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR535	152-0322-00			SEMICONV DEVICE: SILICON, 15V, HOT CARRIER	80009	152-0322-00

Replaceable Electrical Parts—221 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR536	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR556	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR557	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR612	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR613	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR614	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR615	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR621	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR622	152-0401-00			SEMICON D DEVICE:SILICON,3-LAYER,TRIGGER	04713	SPT32K
CR623	152-0107-00	B010100	B010169	SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR623	152-0400-00	B010170		SEMICON D DEVICE:SILICON,400V,1A	80009	152-0400-00
CR624	152-0414-00			SEMICON D DEVICE:SILICON,200V,0.75A	80009	152-0414-00
CR625	152-0414-00	B010100	B020679	SEMICON D DEVICE:SILICON,200V,0.75A	80009	152-0414-00
CR625	152-0413-00	B020680		SEMICON D DEVICE:SILICON,400V,750MA	80009	152-0413-00
CR626	152-0107-00	B010100	B010169	SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR626	152-0400-00	B010170		SEMICON D DEVICE:SILICON,400V,1A	80009	152-0400-00
CR627	152-0107-04	XB020475		SEMICON D DEVICE:SILICON,400V,400MA,SEL	80009	152-0107-04
CR628	152-0107-04	XB020475		SEMICON D DEVICE:SILICON,400V,400MA,SEL	80009	152-0107-04
CR632	152-0400-00			SEMICON D DEVICE:SILICON,400V,1A	80009	152-0400-00
CR633	152-0400-00			SEMICON D DEVICE:SILICON,400V,1A	80009	152-0400-00
CR634	152-0502-00	B010100	B020679	SEMICON D DEVICE:SILICON,20V,5A	04713	1N5823
CR634	152-0582-00	B020680		SEMICON D DEVICE:SILICON,20V,3A	80009	152-0582-00
CR654	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR712	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR713	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR715	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR716	152-0107-00			SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR733	152-0040-00	B010100	B020679	SEMICON D DEVICE:SILICON,600V,1A	80009	152-0040-00
CR733	152-0586-00	B020680		SEMICON D DEVICE:SILICON,600V,500MA	14936	RGP10J
CR734	152-0040-00	B010100	B020679	SEMICON D DEVICE:SILICON,600V,1A	80009	152-0040-00
CR734	152-0586-00	B020680		SEMICON D DEVICE:SILICON,600V,500MA	14936	RGP10J
CR735	152-0040-00	B010100	B020679	SEMICON D DEVICE:SILICON,600V,1A	80009	152-0040-00
CR735	152-0586-00	B020680		SEMICON D DEVICE:SILICON,600V,500MA	14936	RGP10J
CR736	152-0040-00	B010100	B020679	SEMICON D DEVICE:SILICON,600V,1A	80009	152-0040-00
CR736	152-0586-00	B020680		SEMICON D DEVICE:SILICON,600V,500MA	14936	RGP10J
CR756	152-0233-00			SEMICON D DEVICE:SILICON,85V,100MA	80009	152-0233-00
F610	159-0080-00			FUSE,CARTRIDGE:0.2A,250V,SLOW BLOW	75915	213.200
F630	159-0124-00	XB020680		FUSE,WIRE LEAD:3A,125V	75915	272003
J232	129-0312-00			POST,CONTACT:HORIZONTAL INPUT & GROUND	80009	129-0312-00
J233	129-0312-00			POST,CONTACT:HORIZONTAL INPUT & GROUND	80009	129-0312-00
L112	276-0596-00			CORE,TOROID,FER:0.09 ID X 0.19 OD X 0.08"H	78488	57-1657
L114	276-0507-00			SHIELDING BEAD,:0.6UH	78488	57-0180-7D 500B
L192	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L194	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L237	108-0526-00			COIL,RF:50UH	80009	108-0526-00
L571	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L573	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L610	120-0738-00			TRANSFORMER,CMR:	80009	120-0738-00
L626	108-0816-00	XB020807		COIL,RF:4.35MHZ	80009	108-0816-00
L632	108-0574-00			COIL,RF:30UH	80009	108-0574-00
L713	108-0240-00			COIL,RF:FIXED,820UH	76493	B5147
L716	108-0240-00			COIL,RF:FIXED,820UH	76493	B5147
L751	-----			(FURNISHED AS A UNIT WITH V740, TRACE ROTATOR COIL)		
M676	149-0031-01	B010100	B022748	METER,ELEC FREQ:0-200VA,+/-15%	80009	149-0031-01
M676	149-0044-03	B022749		METER,BAT LEVEL:W/CONN AND INS SLEEVE	80009	149-0044-03

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
Q132A,B	151-1057-00			TRANSISTOR:SILICON,FE,N-CHANNEL,DUAL	80009	151-1057-00
Q136A,B	153-0612-00	B010100	B010249	TRANSISTOR:SILICON,VBE,MATCHED	80009	153-0612-00
Q136A,B	153-0612-01	B010250		TRANSISTOR:SILICON,VBE,MATCHED	80009	153-0612-01
Q162A,B	151-0353-00			TRANSISTOR:SILICON,NPN	32293	ITS1251
Q164	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q172A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q212	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q214	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q216	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q218	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q222	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q226	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q232A,B	151-1054-00			TRANSISTOR:SILICON,JFE,N-CHANNEL,DUAL	80009	151-1054-00
Q234	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q236	151-0190-00	B010100	B010579	TRANSISTOR:SILICON,NPN	07263	S032677
Q236	151-0188-00	B010580		TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q242	151-0190-00	B010100	B010169X	TRANSISTOR:SILICON,NPN	07263	S032677
Q244	151-0367-00	B010100	B020849	TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0367-00
Q244	151-0333-00	B020850		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q246	151-0367-00	B010100	B020849	TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0367-00
Q246	151-0333-00	B020850		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q252	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q254	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q256	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q312	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q316	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q322	151-0367-00	B010100	B020849	TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0367-00
Q322	151-0333-00	B020850		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q324	151-0367-00	B010100	B020849	TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0367-00
Q324	151-0333-00	B020850		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q326	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q328	151-0221-00			TRANSISTOR:SILICON,PNP	80009	151-0221-00
Q330	151-0367-00	B010100	B020849	TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0367-00
Q330	151-0333-00	B020850		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q332	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q334	151-0452-00			TRANSISTOR:SILICON,NPN	80009	151-0452-00
Q336A,B	151-1054-00			TRANSISTOR:SILICON,JFE,N-CHANNEL,DUAL	80009	151-1054-00
Q338	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q340	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q342	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q422A,B	151-0353-00			TRANSISTOR:SILICON,NPN	32293	ITS1251
Q424	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q426A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q432	151-0333-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q442A,B	151-0353-00			TRANSISTOR:SILICON,NPN	32293	ITS1251
Q452	151-0452-00			TRANSISTOR:SILICON,NPN	80009	151-0452-00
Q456	151-0452-00			TRANSISTOR:SILICON,NPN	80009	151-0452-00
Q464	151-0452-00			TRANSISTOR:SILICON,NPN	80009	151-0452-00
Q466	151-0452-00			TRANSISTOR:SILICON,NPN	80009	151-0452-00
Q502	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q516	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q518	151-1066-00			TRANSISTOR:SILICON,FE,P-CHANNEL	80009	151-1066-00
Q522	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q526	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q532	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q542	151-0432-00			TRANSISTOR:SILICON,NPN	80009	151-0432-00
Q544	151-0453-00			TRANSISTOR:SILICON,PNP	80009	151-0453-00

Replaceable Electrical Parts—221 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q552	151-0432-00			TRANSISTOR:SILICON,NPN	80009	151-0432-00
Q554	151-0432-00			TRANSISTOR:SILICON,NPN	80009	151-0432-00
Q556	151-0432-00			TRANSISTOR:SILICON,NPN	80009	151-0432-00
Q622	151-0423-00	B010100	B010169	TRANSISTOR:SILICON,NPN	01295	EP2970
Q622	153-0626-00	B010170	B020474	TRANSISTOR:SILICON,NPN,SEL	80009	153-0626-00
Q622	151-0423-00	B020475		TRANSISTOR:SILICON,NPN	01295	EP2970
Q626	151-0423-00	B010100	B010169	TRANSISTOR:SILICON,NPN	01295	EP2970
Q626	153-0626-00	B010170	B020474	TRANSISTOR:SILICON,NPN,SEL	80009	153-0626-00
Q626	151-0423-00	B020475		TRANSISTOR:SILICON,NPN	01295	EP2970
Q634	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q640	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q642	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q644	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q646	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q648	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q660	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q662	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q664	151-1022-00			TRANSISTOR:SILICON,JFE,SEL FROM 2N4392	80009	151-1022-00
Q666	151-0324-00	B010100	B020679	TRANSISTOR:SILICON,PNP	80009	151-0324-00
Q668	151-0324-00	B010100	B020679	TRANSISTOR:SILICON,PNP	80009	151-0324-00
Q666	153-0627-00	B020680		SEMICON DVC SE:SILICON,PNP,MATCHED PAIR	80009	153-0627-00
Q668						
Q754	151-0432-00			TRANSISTOR:SILICON,NPN	80009	151-0432-00
R100	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R112	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R114	321-0646-00			RES.,FXD,FILM:200K OHM,0.5%,0.125W	91637	MFF1816D20002D
R120	321-0624-00			RES.,FXD,FILM:180.2K OHM,0.25%,0.125W	91637	MFF1816D18022C
R121	321-0318-02			RES.,FXD,FILM:20K OHM,0.5%,0.125W	91637	MFF1816D20001D
R123	321-0646-00			RES.,FXD,FILM:200K OHM,0.5%,0.125W	91637	MFF1816D20002D
R124	321-0222-01			RES.,FXD,FILM:2K OHM,0.5%,0.125W	91637	MFF1816G20000D
R126	321-0646-00			RES.,FXD,FILM:200K OHM,0.5%,0.125W	91637	MFF1816D20002D
R127	321-0126-01			RES.,FXD,FILM:200 OHM,0.5%,0.125W	91637	MFF1816G200R0D
R133	321-0159-00			RES.,FXD,FILM:442 OHM,1%,0.125W	91637	MFF1816G442R0F
R134	321-0158-00	B010100	B010419	RES.,FXD,FILM:432 OHM,1%,0.125W	91637	MFF1816G432R0F
R134	321-0157-00	B010420		RES.,FXD,FILM:422 OHM,1%,0.125W	91637	MFF1816G422R0F
R135	311-1007-00	B010100	B010419	RES.,VAR,NONWIR:20 OHM,20%,0.50W	73138	82-38-0
R135	311-0643-00	B010420		RES.,VAR,NONWIR:50 OHM,10%,0.50W	73138	82-33-2
R136	321-0254-00			RES.,FXD,FILM:4.32K OHM,1%,0.125W	91637	MFF1816G43200F
R137	321-0766-06			RES.,FXD,FILM:4.053K OHM,0.25%,0.125W	91637	MFF1816C40530C
R143	321-0661-00			RES.,FXD,FILM:600 OHM,1%,0.125W	91637	MFF1816G600R0F
R144	321-0808-03			RES.,FXD,FILM:800 OHM,0.25%,0.125W	91637	MFF1816D300R0C
R145	321-1121-01			RES.,FXD,FILM:180 OHM,0.5%,0.125W	91637	MFF1816G180R0D
R146	321-0704-00			RES.,FXD,FILM:60 OHM,0.25%,0.125W	91637	MFF1816G60R00D
R147	321-0704-00			RES.,FXD,FILM:60 OHM,0.25%,0.125W	91637	MFF1816G60R00D
R153	321-0140-00			RES.,FXD,FILM:280 OHM,1%,0.125W	91637	MFF1816G280R0F
R154	321-1087-01			RES.,FXD,FILM:79.6 OHM,0.5%,0.125W	91637	MFF1816G79R60D
R155	321-0125-00			RES.,FXD,FILM:196 OHM,1%,0.125W	91637	MFF1816G196R0F
R156	321-0928-07			RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B
R162	321-0212-00			RES.,FXD,FILM:1.58K OHM,1%,0.125W	91637	MFF1816G15800F
R164	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R165	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
R166	321-0143-00			RES.,FXD,FILM:301 OHM,1%,0.125W	91637	MFF1816G301R0F
R167	321-0247-00			RES.,FXD,FILM:3.65K OHM,1%,0.125W	91637	MFF1816G36500F
R173	321-0183-00			RES.,FXD,FILM:787 OHM,1%,0.125W	91637	MFF1816G787R0F
R174	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R175	321-0216-00			RES.,FXD,FILM:1.74K OHM,1%,0.125W	91637	MFF1816G17400F
R176	321-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.125W	91637	MFF1816G13700F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R177	311-1248-00			RES., VAR, NONWIR: 500 OHM, 10%, 0.50W	73138	72X-23-0-501K
R192	317-0047-00			RES., FXD, CMPSN: 4.7 OHM, 5%, 0.125W	01121	BB47G5
R194	317-0047-00			RES., FXD, CMPSN: 4.7 OHM, 5%, 0.125W	01121	BB47G5
R212	315-0272-00			RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
R213	311-1173-00			RES., VAR, NONWIR: 20K OHM, 20%, 0.25W	71450	200-YA5541
	-----			(R213, FURNISHED AS A UNIT WITH S213)		
R214	311-1269-00			RES., VAR, NONWIR: 20K OHM, 10%, 0.50W	32997	3329P-L58-203
R215	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R216	315-0623-00			RES., FXD, CMPSN: 62K OHM, 5%, 0.25W	01121	CB6235
R217	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R218	315-0101-00			RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R222	315-0204-00			RES., FXD, CMPSN: 200K OHM, 5%, 0.25W	01121	CB2045
R223	315-0163-00	B010100	B010579	RES., FXD, CMPSN: 16K OHM, 5%, 0.25W	01121	CB1635
R223	321-0292-00	B010580		RES., FXD, FILM: 10.7K OHM, 1%, 0.125W	91637	MFF1816G10701F
R224	315-0393-00	B010100	B010579	RES., FXD, CMPSN: 39K OHM, 5%, 0.25W	01121	CB3935
R224	321-0326-00	B010580		RES., FXD, FILM: 24.3K OHM, 1%, 0.125W	91637	MFF1816G24301F
R225	315-0193-00	B010100	B010579	RES., FXD, CMPSN: 19K OHM, 5%, 0.25W	01121	CB1935
R225	321-0304-00	B010580		RES., FXD, FILM: 14.3K OHM, 1%, 0.125W	91637	MFF1816G14301F
R226	315-0203-00	B010100	B010579	RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R226	321-0315-00	B010580		RES., FXD, FILM: 18.7K OHM, 1%, 0.125W	91637	MFF1816G18701F
R227	315-0101-00			RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R228	315-0222-00	B010100	B010579	RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R228	321-0239-00	B010580		RES., FXD, FILM: 3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
R229	317-0151-00	B010100	B010169	RES., FXD, CMPSN: 150 OHM, 5%, 0.125W	01121	BB1515
R229	317-0111-00	B010170	B010579	RES., FXD, CMPSN: 110 OHM, 5%, 0.125W	01121	BB1115
R229	321-0103-00	B010580		RES., FXD, FILM: 115 OHM, 1%, 0.125W	91637	MFF1816G115R0F
R232	315-0914-00			RES., FXD, CMPSN: 910K OHM, 5%, 0.25W	01121	CB9145
R233	315-0134-00			RES., FXD, CMPSN: 130K OHM, 5%, 0.25W	01121	CB1345
R234	315-0105-00	B010100	B010579	RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R234	315-0914-00	B010580		RES., FXD, CMPSN: 910K OHM, 5%, 0.25W	01121	CB9145
R235	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R236	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R237	315-0242-00	B010100	B010579	RES., FXD, CMPSN: 2.4K OHM, 5%, 0.25W	01121	CB2425
R237	321-0230-00	B010580		RES., FXD, FILM: 2.43K OHM, 1%, 0.125W	91637	MFF1816G24300F
R238	317-0151-00	B010100	B010169	RES., FXD, CMPSN: 150 OHM, 5%, 0.125W	01121	BB1515
R238	317-0111-00	B010170	B010579	RES., FXD, CMPSN: 110 OHM, 5%, 0.125W	01121	BB1115
R238	321-0103-00	B010580		RES., FXD, FILM: 115 OHM, 1%, 0.125W	91637	MFF1816G115R0F
R239	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R241	315-0151-00	B010100	B010169X	RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
R242	315-0181-00	B010100	B010169	RES., FXD, CMPSN: 180 OHM, 5%, 0.25W	01121	CB1815
R242	315-0331-00	B010170	B010579	RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
R242	321-0147-00	B010580		RES., FXD, FILM: 332 OHM, 1%, 0.125W	91637	MFF1816G332R0F
R243	315-0392-00	B010100	B010579	RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	CB3925
R243	321-0250-00	B010580		RES., FXD, FILM: 3.92K OHM, 1%, 0.125W	91637	MFF1816G39200F
R244	315-0472-00	B010100	B010579	RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R244	321-0258-00	B010580		RES., FXD, FILM: 4.75K OHM, 1%, 0.125W	91637	MFF1816G47500F
R245	315-0431-00	B010100	B010579	RES., FXD, CMPSN: 430 OHM, 5%, 0.25W	01121	CB4315
R245	321-0158-00	B010580		RES., FXD, FILM: 432 OHM, 1%, 0.125W	91637	MFF1816G432R0F
R251	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R252	317-0203-00			RES., FXD, CMPSN: 20K OHM, 5%, 0.125W	01121	BB2035
R253	317-0112-00			RES., FXD, CMPSN: 1.1K OHM, 5%, 0.125W	01121	BB1125
R254	315-0472-00			RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R255	315-0472-00			RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R256	317-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.125W	01121	BB1045
R257	315-0473-00			RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R258	315-0331-00			RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
R310	315-0303-00			RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035

Replaceable Electrical Parts—221 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R311	315-0203-00			RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R312	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R313	315-0202-00			RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
R314	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R315	321-0267-00			RES., FXD, FILM: 5.9K OHM, 1%, 0.125W	91637	MFF1816G59000F
R316	315-0822-00			RES., FXD, CMPSN: 8.2K OHM, 5%, 0.25W	01121	CB8225
R317	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R318	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R321	315-0102-00	XB054451		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R322	315-0222-00			RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R323	315-0272-00			RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
R324	315-0433-00			RES., FXD, CMPSN: 43K OHM, 5%, 0.25W	01121	CB4335
R325	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R326	315-0184-00			RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
R327	315-0432-00			RES., FXD, CMPSN: 4.3K OHM, 5%, 0.25W	01121	CB4325
R328	315-0393-00	B010100	B010579	RES., FXD, CMPSN: 39K OHM, 5%, 0.25W	01121	CB3935
R328	315-0433-00	B010580		RES., FXD, CMPSN: 43K OHM, 5%, 0.25W	01121	CB4335
R331	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R332	315-0243-00			RES., FXD, CMPSN: 24K OHM, 5%, 0.25W	01121	CB2435
R333	315-0392-00			RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	CB3925
R334	315-0331-00			RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
R335	315-0472-00			RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R336	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R337	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R338	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R342	315-0622-00			RES., FXD, CMPSN: 6.2K OHM, 5%, 0.25W	01121	CB6225
R343	315-0152-00			RES., FXD, CMPSN: 1.5K OHM, 5%, 0.25W	01121	CB1525
R344	315-0361-00			RES., FXD, CMPSN: 360 OHM, 5%, 0.25W	01121	CB3615
R345	315-0911-00			RES., FXD, CMPSN: 910 OHM, 5%, 0.25W	01121	CB9115
R346	315-0362-00			RES., FXD, CMPSN: 3.6K OHM, 5%, 0.25W	01121	CB3625
R351	321-0193-00			RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
R352	311-1406-00			RES., VAR, NONWIR: 20K OHM, 0.25W, W/SW	71450	200-YA5557
R353	321-0226-00			RES., FXD, FILM: 2.21K OHM, 1%, 0.125W	91637	MFF1816G22100F
R354	311-1263-00			RES., VAR, NONWIR: 1K OHM, 10%, 0.50W	32997	3329P-L58-102
R355A-F	307-0308-01			RES., FXD, FILM: NETWORK, HYBRID CIRCUIT	80009	307-0308-01
R356	315-0394-00			RES., FXD, CMPSN: 390K OHM, 5%, 0.25W	01121	CB3945
R362	315-0100-00			RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
R363	315-0100-00			RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
R364	315-0100-00			RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
R365	315-0100-00			RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
R413	311-1170-00			RES., VAR, NONWIR: 20K OHM, 20%, 0.25W	71450	UPE270
R415	321-0339-00			RES., FXD, FILM: 33.2K OHM, 1%, 0.125W	91637	MFF1816G33201F
R416	321-0188-00			RES., FXD, FILM: 887 OHM, 1%, 0.125W	91637	MFF1816G887R0F
R417	311-1261-00			RES., VAR, NONWIR: 500 OHM, 10%, 0.50W	32997	3329P-L58-501
R418	311-1174-00			RES., VAR, NONWIR: 5K OHM, 20%, 0.25W	71450	200-YA5542
R422	321-0212-00			RES., FXD, FILM: 1.58K OHM, 1%, 0.125W	91637	MFF1816G15800F
R423	321-0181-00			RES., FXD, FILM: 750 OHM, 1%, 0.125W	91637	MFF1816G750R0F
R424	315-0221-00			RES., FXD, CMPSN: 220 OHM, 5%, 0.25W	01121	CB2215
R425	321-0183-00			RES., FXD, FILM: 787 OHM, 1%, 0.125W	91637	MFF1816G787R0F
R432	321-0291-00			RES., FXD, FILM: 10.5K OHM, 1%, 0.125W	91637	MFF1816G10501F
R433	321-0274-00			RES., FXD, FILM: 6.98K OHM, 1%, 0.125W	91637	MFF1816G69800F
R434	321-0216-00			RES., FXD, FILM: 1.74K OHM, 1%, 0.125W	91637	MFF1816G17400F
R435	321-0212-00			RES., FXD, FILM: 1.58K OHM, 1%, 0.125W	91637	MFF1816G15800F
R436	321-0254-00			RES., FXD, FILM: 4.32K OHM, 1%, 0.125W	91637	MFF1816G43200F
R437	315-0125-00			RES., FXD, CMPSN: 1.2M OHM, 5%, 0.25W	01121	CB1255
R442	321-0255-00			RES., FXD, FILM: 4.42K OHM, 1%, 0.125W	91637	MFF1816G44200F
R446	321-0176-00			RES., FXD, FILM: 665 OHM, 1%, 0.125W	91637	MFF1816G665R0F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R447	321-0255-00			RES., FXD, FILM: 4.42K OHM, 1%, 0.125W	91637	MFF1816G44200F
R453	321-0360-00			RES., FXD, FILM: 54.9K OHM, 1%, 0.125W	91637	MFF1816G54901F
R456	321-0312-00			RES., FXD, FILM: 17.4K OHM, 1%, 0.125W	91637	MFF1816G17401F
R458	321-0304-00			RES., FXD, FILM: 14.3K OHM, 1%, 0.125W	91637	MFF1816G14301F
R462	321-0435-00			RES., FXD, FILM: 332K OHM, 1%, 0.125W	91637	MFF1816G33202F
R466	321-0318-00			RES., FXD, FILM: 20K OHM, 1%, 0.125W	91637	MFF1816G20001F
R468	321-0304-00			RES., FXD, FILM: 14.3K OHM, 1%, 0.125W	91637	MFF1816G14301F
R501	315-0472-00			RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R502	315-0470-00			RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	CB4705
R503	321-0641-00			RES., FXD, FILM: 1.8K OHM, 1%, 0.125W	91637	MFF1816G18000F
R504	321-0280-00			RES., FXD, FILM: 8.06K OHM, 1%, 0.125W	91637	MFF1816G80600F
R505	311-1245-00			RES., VAR, NONWIR: 10K OHM, 10%, 0.50W	73138	72-28-0
R511	321-0297-00			RES., FXD, FILM: 12.1K OHM, 1%, 0.125W	91637	MFF1816G12101F
R512	315-0303-00			RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R513	315-0224-00			RES., FXD, CMPSN: 220K OHM, 5%, 0.25W	01121	CB2245
R514	315-0473-00			RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R515	321-0263-00			RES., FXD, FILM: 5.36K OHM, 1%, 0.125W	91637	MFF1816G53600F
R516	321-0260-00			RES., FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
R517	321-0325-00			RES., FXD, FILM: 23.7K OHM, 1%, 0.125W	91637	MFF1816G23701F
R518	311-1170-00			RES., VAR, NONWIR: 20K OHM, 20%, 0.25W	71450	UPE270
R519	315-0471-00			RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R522	321-0263-00			RES., FXD, FILM: 5.36K OHM, 1%, 0.125W	91637	MFF1816G53600F
R523	315-0201-00			RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R524	321-0219-00			RES., FXD, FILM: 1.87K OHM, 1%, 0.125W	91637	MFF1816G18700F
R525	321-0184-00			RES., FXD, FILM: 806 OHM, 1%, 0.125W	91637	MFF1816G806R0F
R526	321-0185-00			RES., FXD, FILM: 825 OHM, 1%, 0.125W	91637	MFF1816G825R0F
R527	321-0264-00			RES., FXD, FILM: 5.49K OHM, 1%, 0.125W	91637	MFF1816G54900F
R532	321-0306-00			RES., FXD, FILM: 15K OHM, 1%, 0.125W	91637	MFF1816G15001F
R533	311-1245-00			RES., VAR, NONWIR: 10K OHM, 10%, 0.50W	73138	72-28-0
R534	321-0301-00			RES., FXD, FILM: 13.3K OHM, 1%, 0.125W	91637	MFF1816G13301F
R535	321-0289-00			RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R536	315-0474-00			RES., FXD, CMPSN: 470K OHM, 5%, 0.25W	01121	CB4745
R537	315-0101-00			RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R542	321-0414-00			RES., FXD, FILM: 200K OHM, 1%, 0.125W	91637	MFF1816G20002F
R543	321-0625-00			RES., FXD, FILM: 5.88K OHM, 1%, 0.125W	91637	MFF1816G58800F
R544	321-0179-00			RES., FXD, FILM: 715 OHM, 1%, 0.125W	91637	MFF1816G715R0F
R545	321-0373-00			RES., FXD, FILM: 75K OHM, 1%, 0.125W	91637	MFF1816G75001F
R548	321-0407-00			RES., FXD, FILM: 169K OHM, 1%, 0.125W	91637	MFF1816G16902F
R552	321-0332-00			RES., FXD, FILM: 28K OHM, 1%, 0.125W	91637	MFF1816G28001F
R553	321-0306-00			RES., FXD, FILM: 15K OHM, 1%, 0.125W	91637	MFF1816G15001F
R555	315-0203-00			RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R556	321-0407-00			RES., FXD, FILM: 169K OHM, 1%, 0.125W	91637	MFF1816G16902F
R557	321-0355-00			RES., FXD, FILM: 48.7K OHM, 1%, 0.125W	91637	MFF1816G48701F
R612	315-0155-00			RES., FXD, CMPSN: 1.5M OHM, 5%, 0.25W	01121	CB1555
R613	315-0106-00			RES., FXD, CMPSN: 10M OHM, 5%, 0.25W	01121	CB1065
R614	315-0106-00			RES., FXD, CMPSN: 10M OHM, 5%, 0.25W	01121	CB1065
R622	315-0106-00	B010100	B020806	RES., FXD, CMPSN: 10M OHM, 5%, 0.25W	01121	CB1065
R622	315-0185-00	B020807		RES., FXD, CMPSN: 1.8M OHM, 5%, 0.25W	01121	CB1855
R623	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R624	315-0133-00	XB020807		RES., FXD, CMPSN: 13K OHM, 5%, 0.25W	01121	CB1335
R626	301-0822-00	B010100		RES., FXD, CMPSN: 8.2K OHM, 5%, 0.50W	01121	EB8225
R626	301-0123-00	B020475	B020806	RES., FXD, CMPSN: 12K OHM, 5%, 0.50W	01121	EB1235
R626	315-0183-00	B020807		RES., FXD, CMPSN: 18K OHM, 5%, 0.25W	01121	CB1835
R627	315-0102-00	XB020807		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R632	307-0116-00			RES., FXD, CMPSN: 9.1 OHM, 5%, 0.25W	01121	CB91G5
R633	315-0200-00	XB020680		RES., FXD, CMPSN: 20 OHM, 5%, 0.25W	01121	CB2005
R634	315-0200-00			RES., FXD, CMPSN: 20 OHM, 5%, 0.25W	01121	CB2005

Replaceable Electrical Parts—221 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
R636	315-0271-00			RES., FXD, CMPSN: 270 OHM, 5%, 0.25W	01121	CB2715
R642	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R643	321-0250-00			RES., FXD, FILM: 3.92K OHM, 1%, 0.125W	91637	MFF1816G39200F
R644	311-1239-00			RES., VAR, NONWIR: 2.5K OHM, 10%, 0.50W	73138	72X-76-0-252K
R645	321-0281-00			RES., FXD, FILM: 8.25K OHM, 1%, 0.125W	91637	MFF1816G82500F
R646	315-0562-00			RES., FXD, CMPSN: 5.6K OHM, 5%, 0.25W	01121	CB5625
R647	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R648	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R654	315-0273-00			RES., FXD, CMPSN: 27K OHM, 5%, 0.25W	01121	CB2735
R655	315-0362-00			RES., FXD, CMPSN: 3.6K OHM, 5%, 0.25W	01121	CB3625
R656	321-0289-00			RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R657	321-0289-00			RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R659	315-0270-00	XB022090		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
R660	315-0270-00	XB022090		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
R661	321-0289-00			RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R662	311-1245-00			RES., VAR, NONWIR: 10K OHM, 10%, 0.50W	73138	72-28-0
R663	321-0289-00			RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R664	321-0452-00			RES., FXD, FILM: 499K OHM, 1%, 0.125W	91637	MFF1816G49902F
R665	315-0513-00			RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R666	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R667	307-0375-00			RES., FXD, FILM: 100M OHM	80009	307-0375-00
R668	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R669	315-0151-00	XB020680		RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
R676	315-0153-00	B010100	B022748	RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R676	315-0392-00	B022749		RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	CB3925
R731	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R732	315-0205-00			RES., FXD, CMPSN: 2M OHM, 5%, 0.25W	01121	CB2055
R733	311-1646-00			RES., FXD, VAR, NONWIR: 2M OHM, 20%, 0.50W	73138	72-97-0
R734	315-0205-00			RES., FXD, CMPSN: 2M OHM, 5%, 0.25W	01121	CB2055
R735	315-0205-00			RES., FXD, CMPSN: 2M OHM, 5%, 0.25W	01121	CB2055
R736	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R738	311-1549-00			RES., VAR, NONWIR: 2M OHM, 20%, 0.25W (R738, FURNISHED AS A UNIT WITH S738)	71450	311
R739	311-1399-00			RES., VAR, NONWIR: 5M OHM, 20%, 0.50W	73138	72-90-0
R751	311-1271-00			RES., VAR, NONWIR: 50K OHM, 10%, 0.50W	32997	3329P-L58-503
R752	311-1241-00			RES., VAR, NONWIR: 100K OHM, 10%, 0.5W	32997	3386X-T07-104
R753	311-1241-00			RES., VAR, NONWIR: 100K OHM, 10%, 0.5W	32997	3386X-T07-104
R754	315-0102-03	XB054451		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R756	321-0364-00			RES., FXD, FILM: 60.4K OHM, 1%, 0.125W	91637	MFF1816G60401F
R757	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
S111	260-0984-01			SWITCH, SLIDE: DP3T W/PLASTIC PLATE	79727	G-128SPC/
S121	214-1863-01			DETENT, RTRY SW: WITH CONTACTS	80009	214-1863-01
S213	-----			(S213 FURNISHED AS A UNIT WITH R213)		
S235	260-0723-00			SWITCH, SLIDE: DPDT, 0.5A, 125VAC	79727	GF126-0028
S350	214-1875-01			DETENT, RTRY SW: WITH CONTACTS	80009	214-1875-01
S521	260-0723-00			SWITCH, SLIDE: DPDT, 0.5A, 125VAC	79727	GF126-0028
S738	-----			(S738 FURNISHED AS A UNIT WITH R738)		
T312	120-0878-00			XFMR TOROID: 3 WINDINGS	80009	120-0878-00
T623	120-0877-00	B010100	B020474	XFMR, BASE DRIVE:	80009	120-0877-00
T623	120-0946-00	B020475		XFMR, BASE DRIVE:	80009	120-0946-00
T633	120-0876-00			XFMR, INVERTER: POT CORE	80009	120-0876-00
T701	120-0875-00			XFMR, PWR, STPDN: POT CORE	80009	120-0875-00
U654	156-0067-00			MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	80009	156-0067-00
V740	154-0705-00			ELECTRON TUBE: CRT	80009	154-0705-00
VR534	152-0265-00			SEMICOND DEVICE: ZENER, 0.4W, 24V, 5%	80009	152-0265-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
VR625	152-0168-00	XB020807	SEMICOND DEVICE:ZENER,0.4W,12V,5%	80009	152-0168-00
VR626	152-0168-00	XB020807	SEMICOND DEVICE:ZENER,0.4W,12V,5%	80009	152-0168-00
VR634	152-0243-00		SEMICOND DEVICE:ZENER,0.4W,15V,5%	14552	1N965B
VR654	152-0166-00		SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0166-00
VR738	152-0287-00		SEMICOND DEVICE:ZENER,0.4W,110V,5%	04713	1N986B
VR757	152-0127-00		SEMICOND DEVICE:ZENER,0.4W,7.5V,5%	80009	152-0127-00

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
 Values less than one are in microfarads (μ F).
 Resistors = Ohms (Ω).

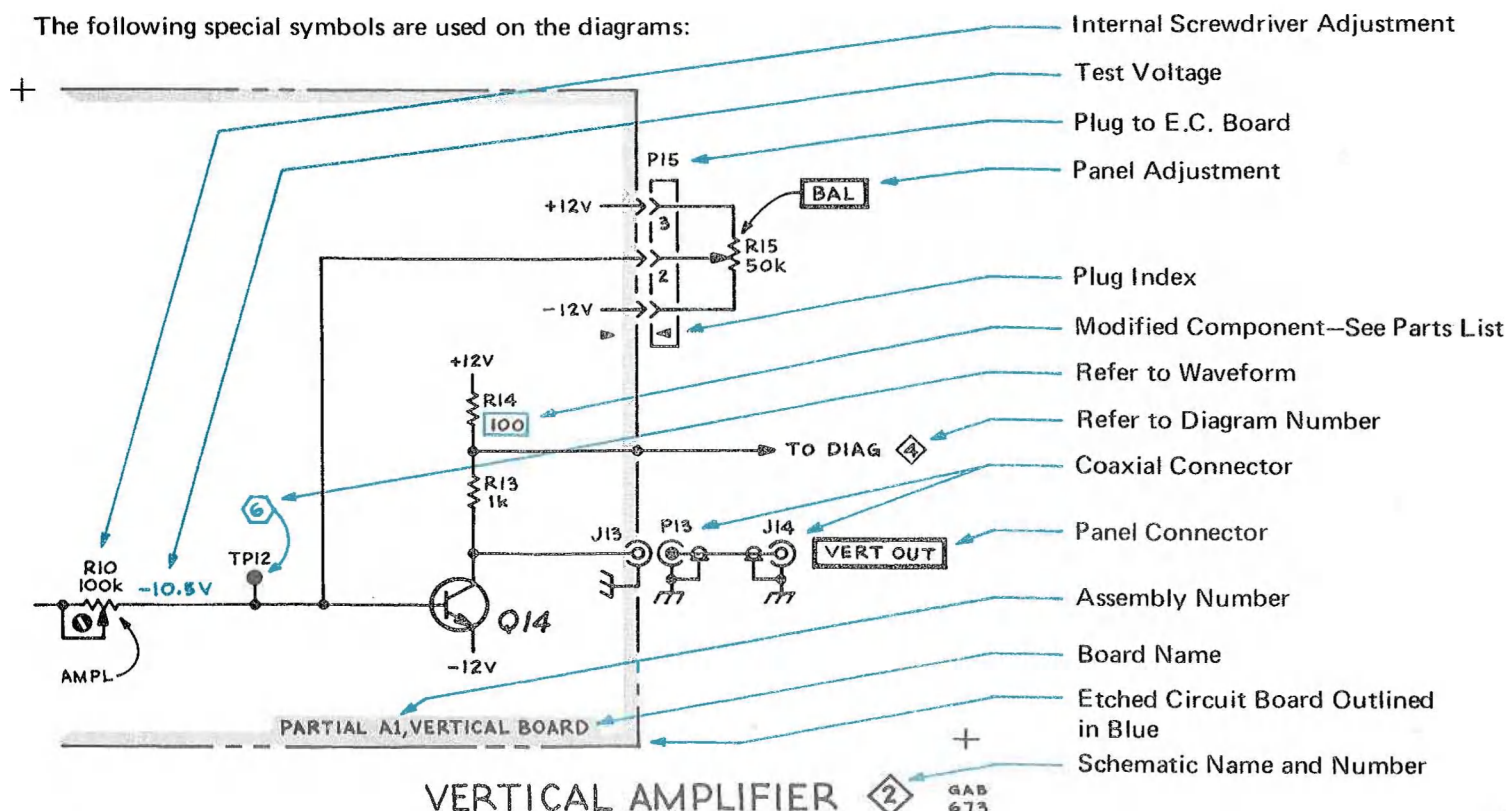
Symbols used on the diagrams are based on USA Standard Y32.2-1967.

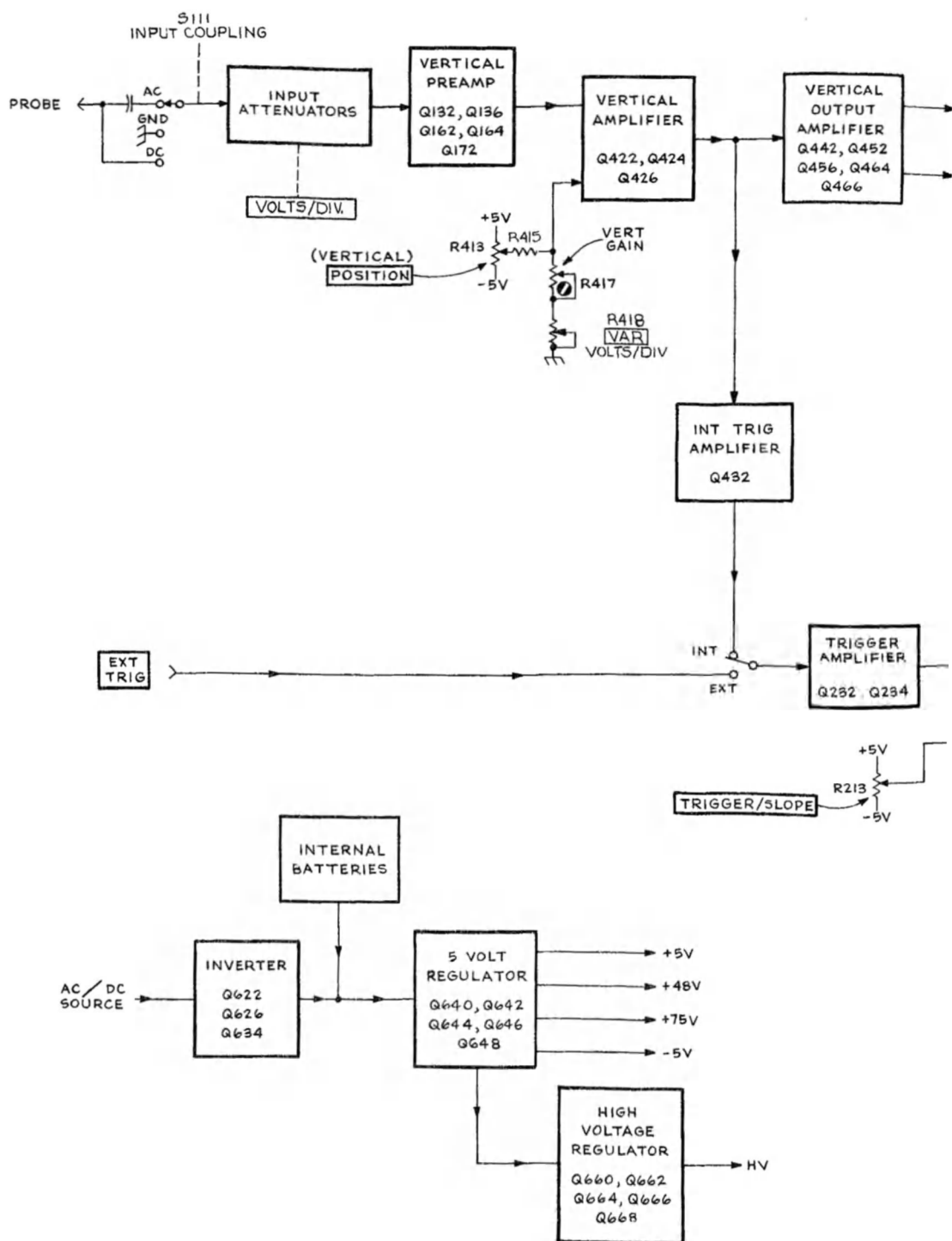
Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

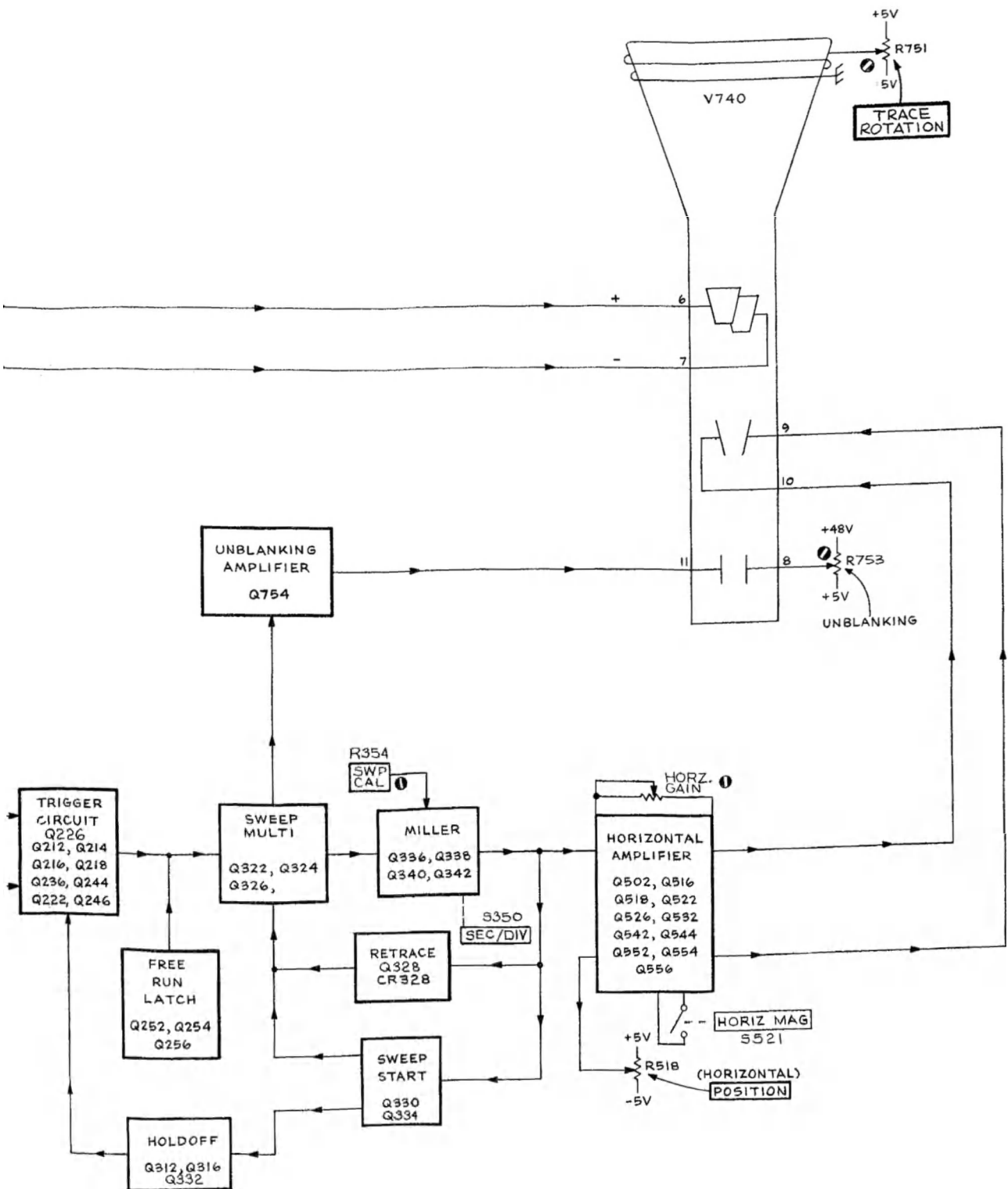
The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)	H	Heat dissipating device (heat sink, heat radiator, etc.)	RT	Thermistor
AT	Attenuator, fixed or variable	HR	Heater	S	Switch
B	Motor	HY	Hybrid circuit	T	Transformer
BT	Battery	J	Connector, stationary portion	TC	Thermocouple
C	Capacitor, fixed or variable	K	Relay	TP	Test point
CB	Circuit breaker	L	Inductor, fixed or variable	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	V	Electron tube
DL	Delay line	M	Meter	VR	Voltage regulator (zener diode, etc.)
DS	Indicating device (lamp)	P	Connector, movable portion	Y	Crystal
E	Spark Gap	Q	Transistor or silicon-controlled rectifier	Z	Phase shifter
F	Fuse	R	Resistor, fixed or variable		
FL	Filter				

The following special symbols are used on the diagrams:







BLOCK DIAGRAM

Note : Shield removed

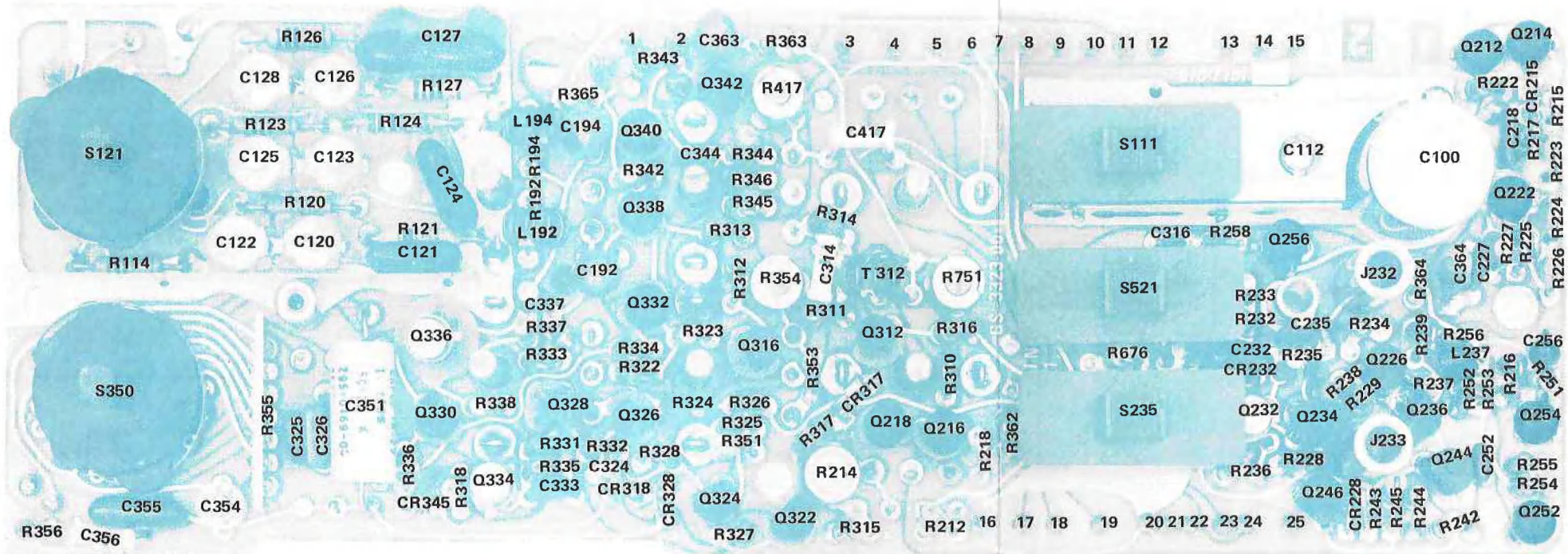


Fig. 9-1. A1—Input circuit board (Front) SNB020475 & above.

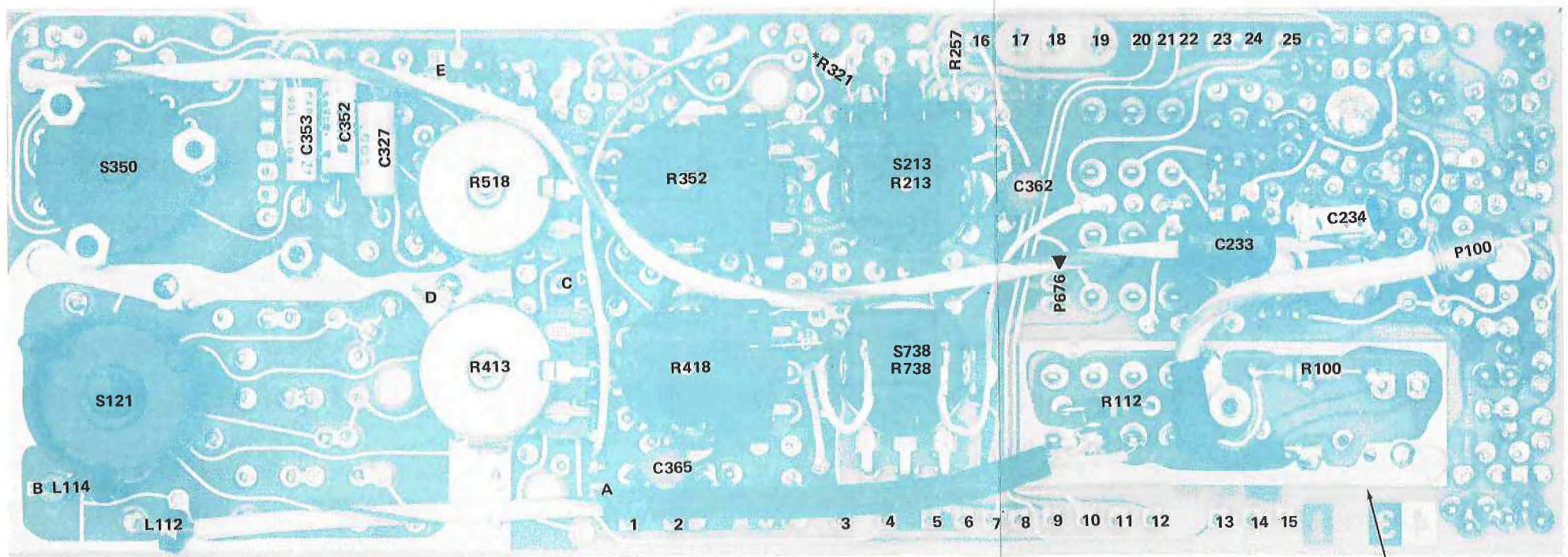


Fig. 9-2. A1—Input circuit board (back) SN B020475 & above.

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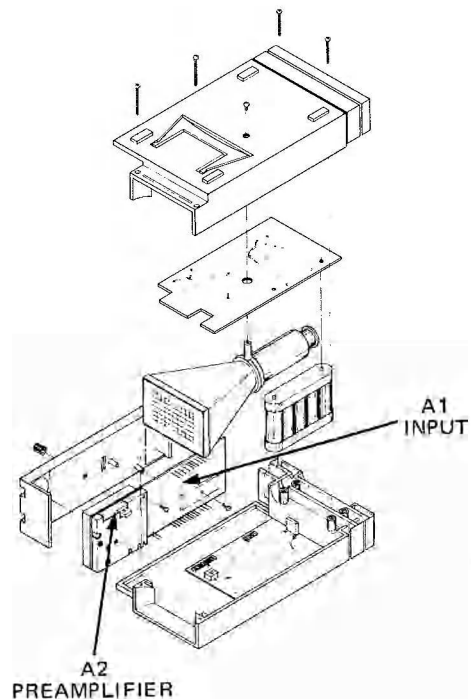
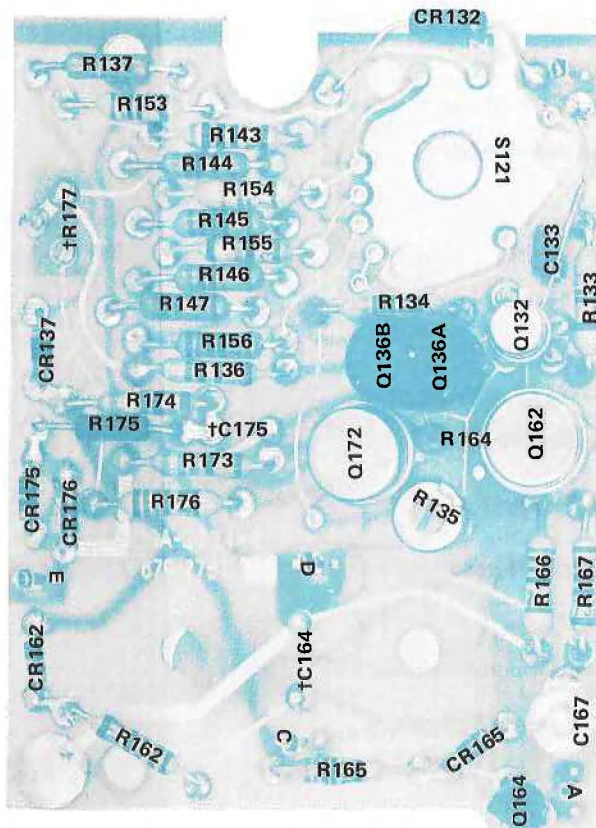
Note: Shield Removed

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*See Parts List for
serial number ranges.

†Located on back of board.

‡Soldered on
emitter lead.



VOLTAGES AND WAVEFORMS

RECOMMENDED TEST EQUIPMENT

ITEM	SPECIFICATIONS	RECOMMENDED TYPE
Oscilloscope	Frequency response 5 megahertz	Tektronix 221 or equivalent.
Voltmeter nonloading digital multi-meter	Input impedance: 10 M Ω Range: 0 – 1 kV	Tektronix 7D13 Digital multimeter, test oscilloscope with readout is required. Fairchild Model 7050 or equivalent.

The voltages and waveforms shown on this diagram were obtained by using the following test set-up and test equipment.

Voltage Measurements

Set the front and side panel controls for a vertically centered trace (TRIGGER/SLOPE set to AUTO PRESET).

Input coupling switch to ground (GND).

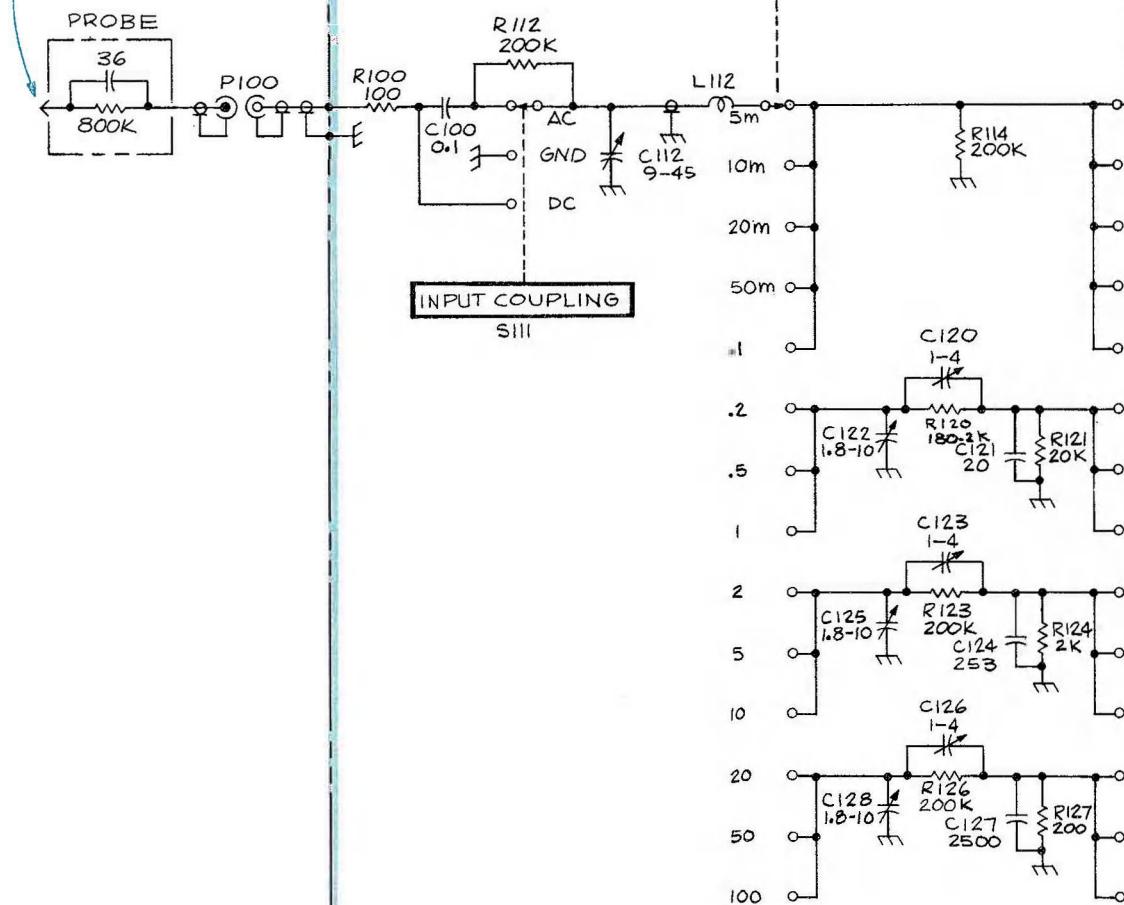
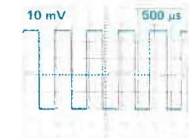
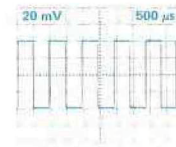
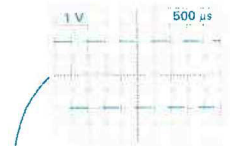
Voltmeter common is connected to the instrument common.

Waveform Measurements

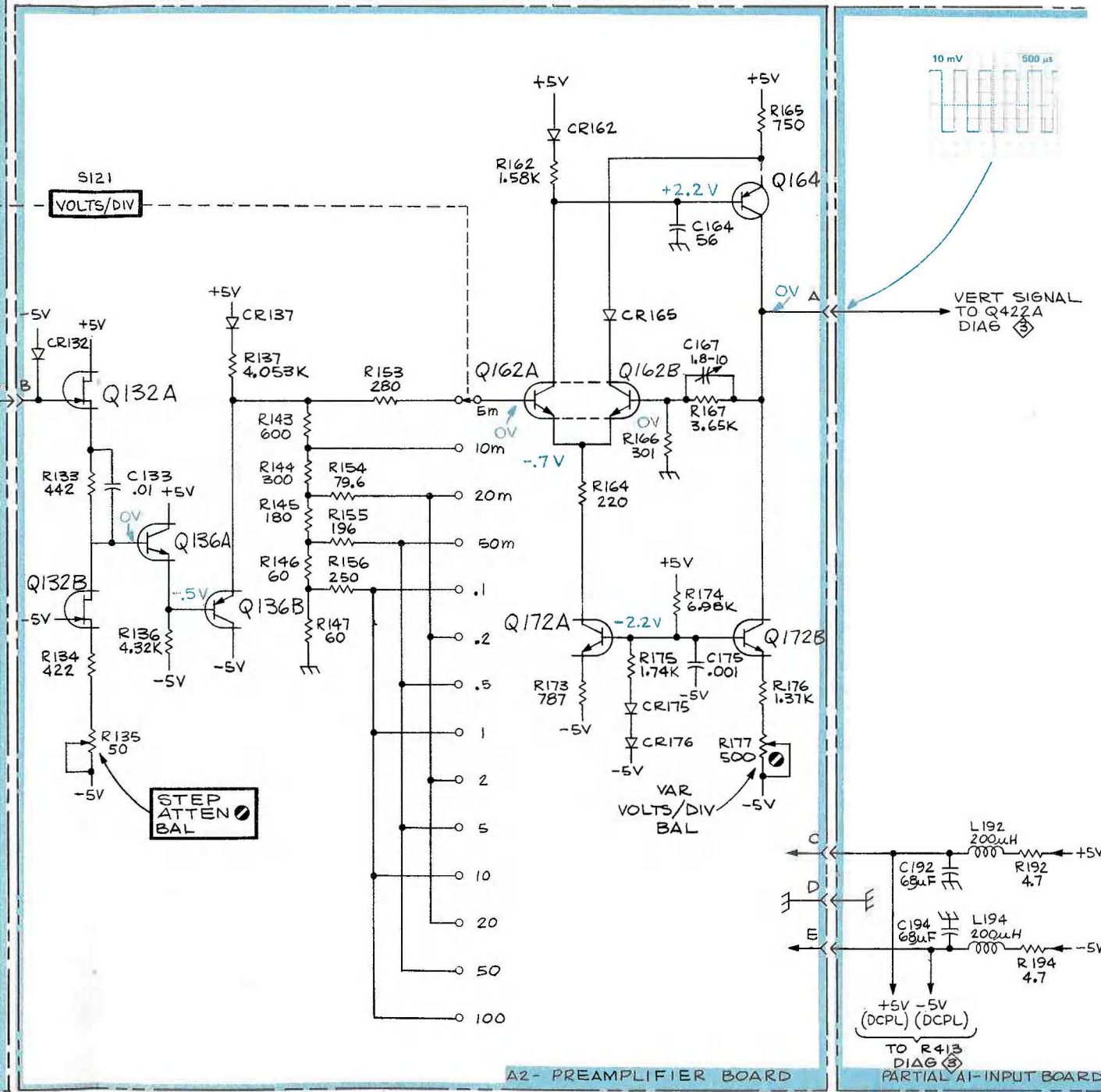
The 221 Oscilloscope under test: The vertical deflection is set to 1 V with a four volt square wave connected to the probe tip, and the SEC/DIV switch is set for 0.5 m. The TRIGGER LEVEL/SLOPE set to AUTO PRESET with a triggered display. Any change in the set-up will be noted on the photograph (HORIZ-MAG 10X).

Test Oscilloscope

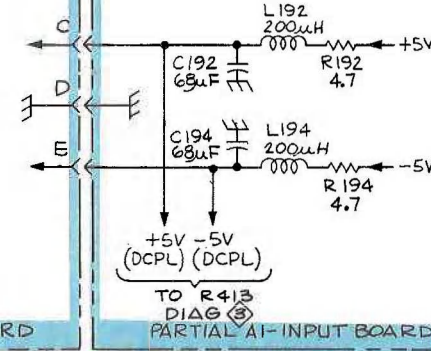
The test oscilloscope is internally triggered; the vertical deflection factor and horizontal timing is indicated on the waveform photograph. The vertical input is AC coupled, so repositioning of the display is not necessary after checking difference test points. The tolerance of the voltages and waveforms is 20%.



PARTIAL A1- INPUT BOARD



A2- PREAMPLIFIER BOARD



PARTIAL A1- INPUT BOARD

VOLTAGES AND WAVEFORMS

RECOMMENDED TEST EQUIPMENT

ITEM	SPECIFICATIONS	RECOMMENDED TYPE
Oscilloscope	Frequency response 5 megahertz	Tektronix 221 or equivalent.
Voltmeter nonloading digital multi-meter	Input impedance: 10 M Ω Range: 0 – 1 kV	Tektronix 7D13 Digital multimeter, test oscilloscope with readout is required. Fairchild Model 7050 or equivalent.

The voltages and waveforms shown on this diagram were obtained by using the following test set-up and test equipment.

Voltage Measurements

Set the front and side panel controls for a vertically centered trace (TRIGGER/SLOPE set to AUTO PRESET).

Input coupling switch to ground (GND).

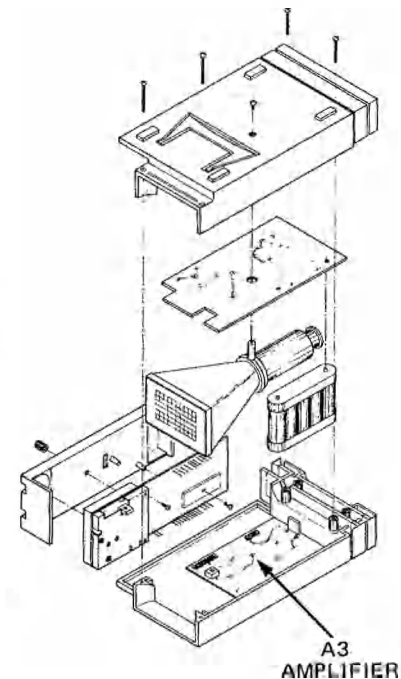
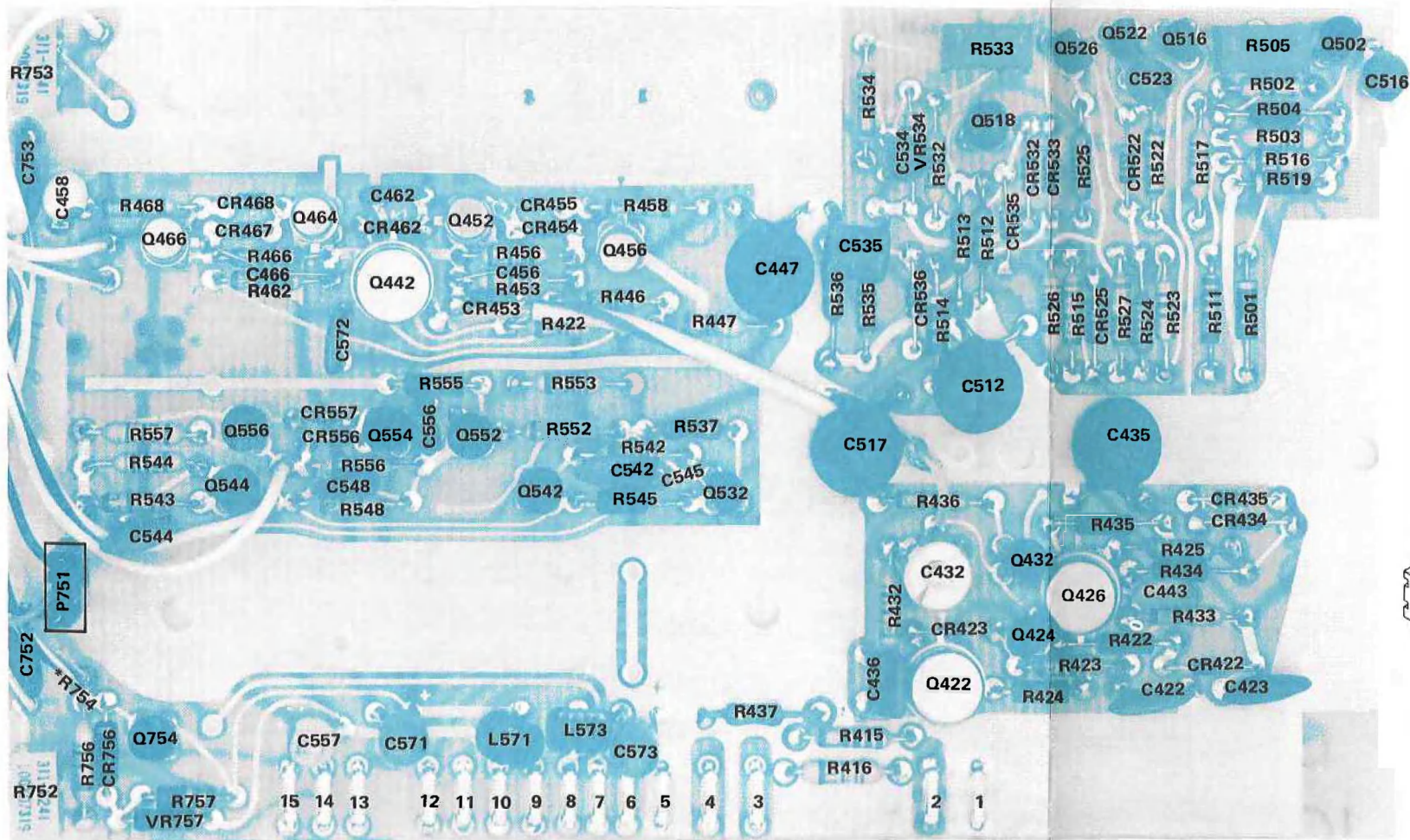
Voltmeter common is connected to the instrument common.

Waveform Measurements

The 221 Oscilloscope under test: The vertical deflection is set to 1 V with a four volt square wave connected to the probe tip, and the SEC/DIV switch is set for 0.5 m. The TRIGGER LEVEL/SLOPE set to AUTO PRESET with a triggered display. Any change in the set-up will be noted on the photograph (HORIZ-MAG 10X).

Test Oscilloscope

The test oscilloscope is internally triggered; the vertical deflection factor and horizontal timing is indicated on the waveform photograph. The vertical input is AC coupled, so repositioning of the display is not necessary after checking difference test points. The tolerance of the voltages and waveforms is 20%.



NOTE: CR469 and CR470 are located on reverse side of board SN B033994 & up.

FIG. 9-5. A3-Amplifier circuit board.

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*See Parts List for serial number ranges.

VOLTAGES AND WAVEFORMS

RECOMMENDED TEST EQUIPMENT

ITEM	SPECIFICATIONS	RECOMMENDED TYPE
Oscilloscope	Frequency response 5 megahertz	Tektronix 221 or equivalent.
Voltmeter nonloading digital multi-meter	Input impedance: 10 M Ω Range: 0 – 1 kV	Tektronix 7D13 Digital multimeter, test oscilloscope with readout is required. Fairchild Model 7050 or equivalent.

The voltages and waveforms shown on this diagram were obtained by using the following test set-up and test equipment.

Voltage Measurements

Set the front and side panel controls for a vertically centered trace (TRIGGER/SLOPE set to AUTO PRESET).

Input coupling switch to ground (GND).

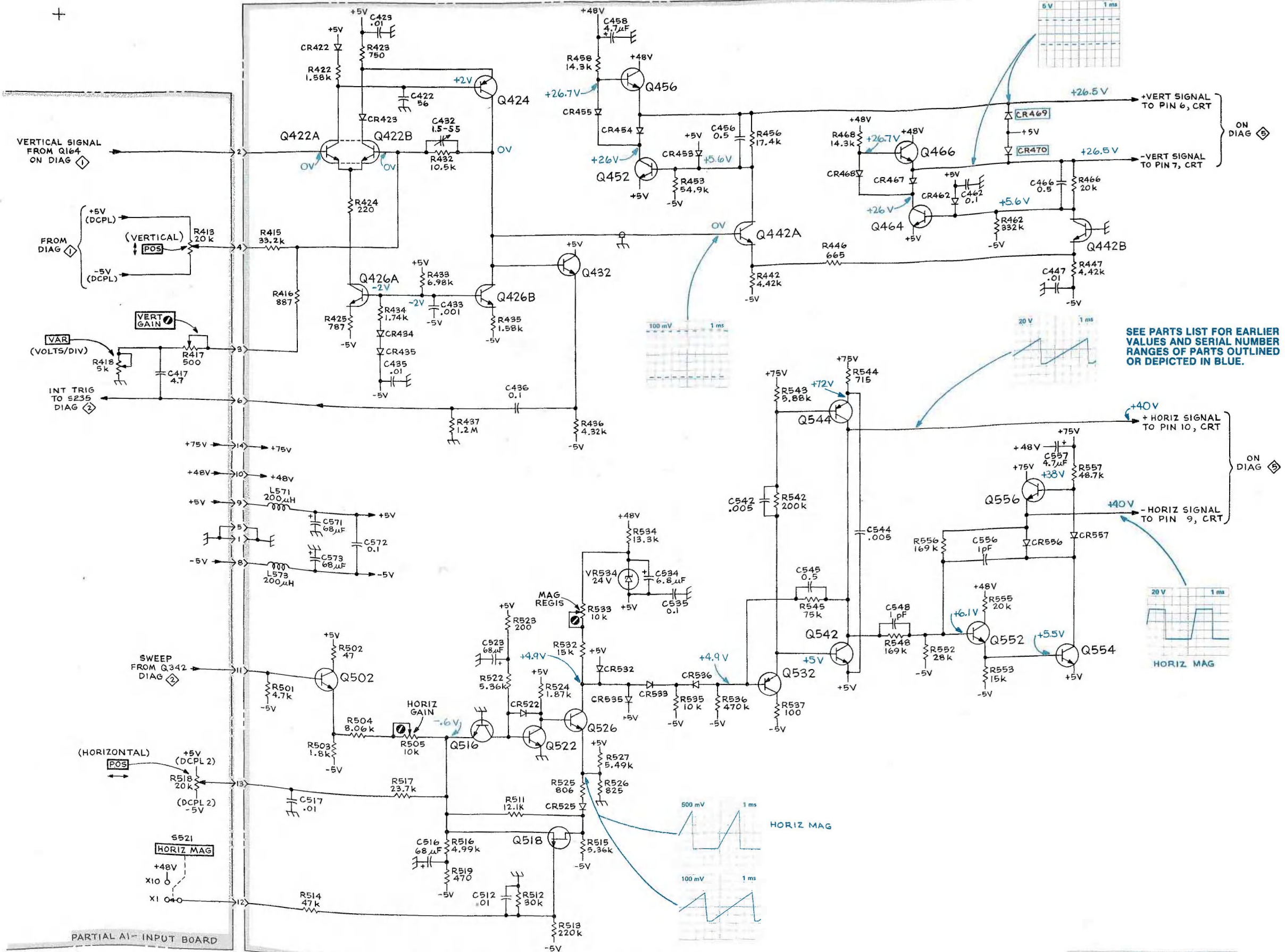
Voltmeter common is connected to the instrument common.

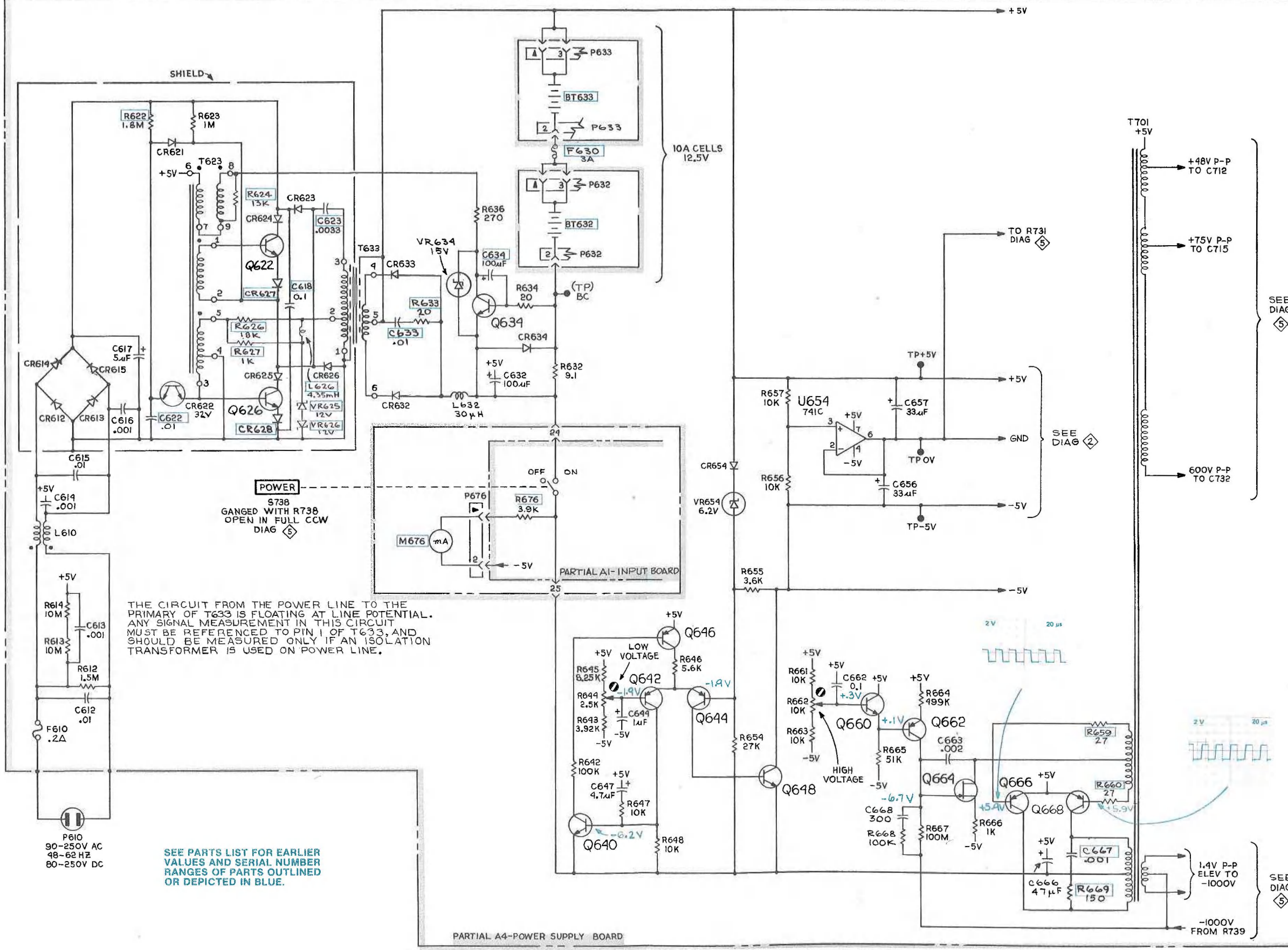
Waveform Measurements

The 221 Oscilloscope under test: The vertical deflection is set to 1 V with a four volt square wave connected to the probe tip, and the SEC/DIV switch is set for 0.5 m. The TRIGGER LEVEL/SLOPE set to AUTO PRESET with a triggered display. Any change in the set-up will be noted on the photograph (HORIZ-MAG 10X).

Test Oscilloscope

The test oscilloscope is internally triggered; the vertical deflection factor and horizontal timing is indicated on the waveform photograph. The vertical input is AC coupled, so repositioning of the display is not necessary after checking difference test points. The tolerance of the voltages and waveforms is 20%.





VOLTAGES AND WAVEFORMS

RECOMMENDED TEST EQUIPMENT

ITEM	SPECIFICATIONS	RECOMMENDED TYPE
Oscilloscope	Frequency response 5 megahertz	Tektronix 221 or equivalent.
Voltmeter nonloading digital multi-meter	Input impedance: 10 M Ω Range: 0 – 1 kV	Tektronix 7D13 Digital multimeter, test oscilloscope with readout is required. Fairchild Model 7050 or equivalent.

The voltages and waveforms shown on this diagram were obtained by using the following test set-up and test equipment.

Voltage Measurements

Set the front and side panel controls for a vertically centered trace (TRIGGER/SLOPE set to AUTO PRESET).

Input coupling switch to ground (GND).

Voltmeter common is connected to the instrument common.

Waveform Measurements

The 221 Oscilloscope under test: The vertical deflection is set to 1 V with a four volt square wave connected to the probe tip, and the SEC/DIV switch is set for 0.5 m. The TRIGGER LEVEL/SLOPE set to AUTO PRESET with a triggered display. Any change in the set-up will be noted on the photograph (HORIZ-MAG 10X).

Test Oscilloscope

The test oscilloscope is internally triggered; the vertical deflection factor and horizontal timing is indicated on the waveform photograph. The vertical input is AC coupled, so repositioning of the display is not necessary after checking difference test points. The tolerance of the voltages and waveforms is 20%.

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number

00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component

Attaching parts for Assembly and/or Component

---*---

Detail Part of Assembly and/or Component

Attaching parts for Detail Part

---*---

Parts of Detail Part

Attaching parts for Parts of Detail Part

---*---

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol ---*--- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

INCH	ELECTRN	IN	INCH	SE	SINGLE END
# NUMBER SIZE	ELEC	INCAND	INCANDESCENT	SECT	SECTION
ACTR ACTUATOR	ELCTLT	INSUL	INSULATOR	SEMCOND	SEMICONDUCTOR
ADPTR ADAPTER	ELEM	INTL	INTERNAL	SHLD	SHIELD
ALIGN ALIGNMENT	EPL	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL ALUMINUM	EQPT	MACH	MACHINE	SKT	SOCKET
ASSEM ASSEMBLED	EXT	MECH	MECHANICAL	SL	SLIDE
ASSY ASSEMBLY	FIL	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN ATTENUATOR	FLEX	NIP	NIPPLE	SLVG	SLEEVEING
AWG AMERICAN WIRE GAGE	FLH	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD BOARD	FLTR	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT BRACKET	FR	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS BRASS	FSTNR	OVH	OVAL HEAD	STL	STEEL
BRZ BRONZE	FT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG BUSHING	FXD	PL	PLAIN or PLATE	T	TUBE
CAB CABINET	GSKT	PLSTC	PLASTIC	TERM	TERMINAL
CAP CAPACITOR	HDL	PN	PART NUMBER	THD	THREAD
CER CERAMIC	HEX	PNH	PAN HEAD	THK	THICK
CHAS CHASSIS	HEX HD	PWR	POWER	TNSN	TENSION
CKT CIRCUIT	HEX SOC	RCPT	RECEPTACLE	TPG	TAPPING
COMP COMPOSITION	HLCPS	RES	RESISTOR	TRH	TRUSS HEAD
CONN CONNECTOR	HLEXT	RGD	RIGID	V	VOLTAGE
COV COVER	HV	RLF	RELIEF	VAR	VARIABLE
CPLG COUPLING	IC	RTNR	RETAINER	W/	WITH
CRT CATHODE RAY TUBE	ID	SCH	SOCKET HEAD	WSHR	WASHER
DEG DEGREE	IDNT	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR DRAWER	IMPLR	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

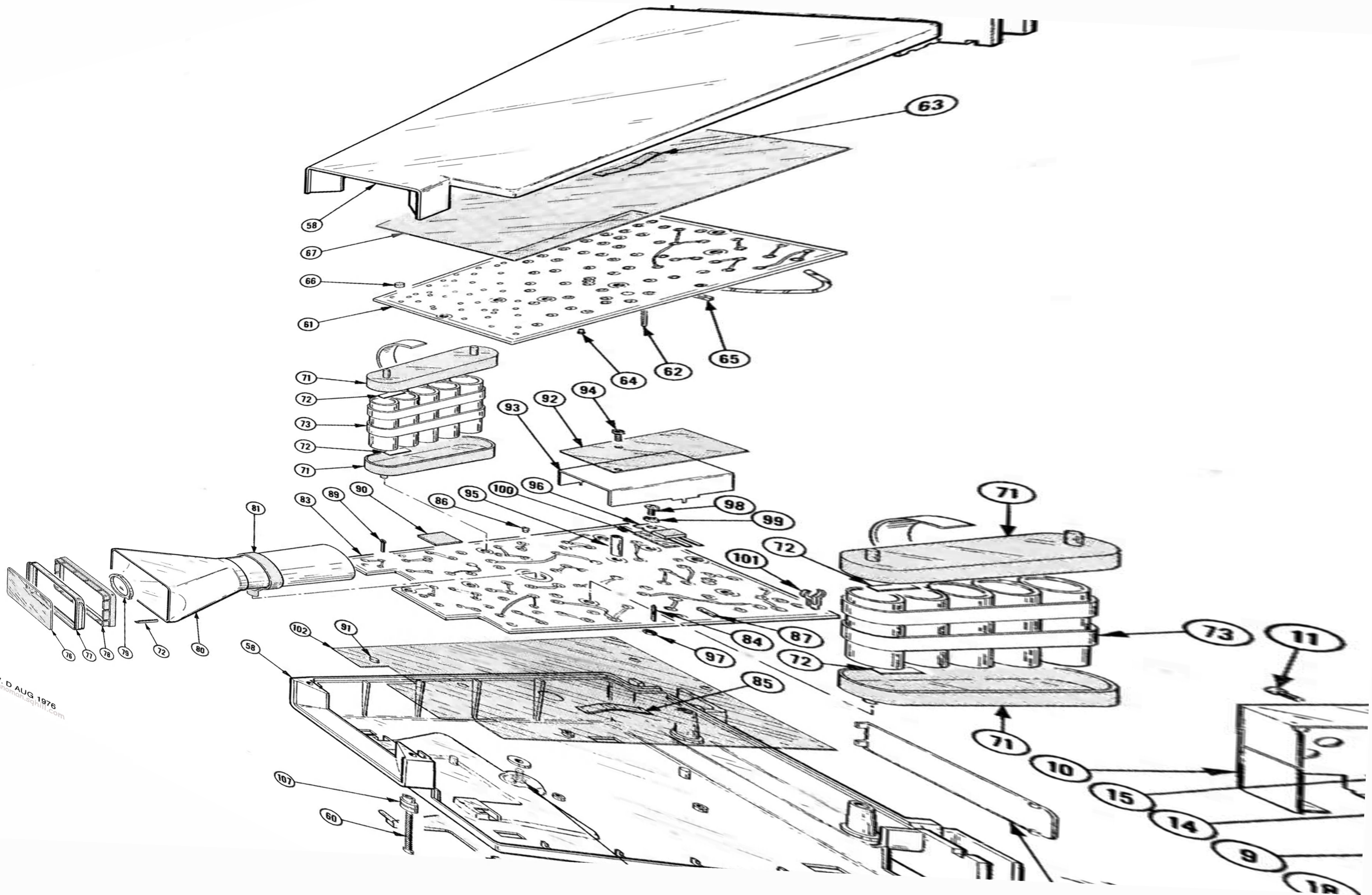
Mfr. Code	Manufacturer	Address	City, State, Zip
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
04963	MINNESOTA MINING AND MFG. CO., ADHESIVES COATINGS AND SEALERS DIVISION	3M CENTER	ST. PAUL, MN 55101
08530	RELIANCE MICA CORP.	342-39TH ST.	BROOKLYN, NY 11232
16428	BELDEN CORP.	P. O..BOX 1331	RICHMOND, IN 47374
18121	WILSHIRE FOAM PRODUCTS, INC.	2665 COLUMBIA ST.	TORRANCE, CA 90503
19209	GENERAL ELECTRIC CO., ELECTRONIC CAPACITOR AND BATTERY PRODUCTS DEPT. BATTERY PRODUCTS SEC.	P. O. BOX 114	GAINESVILLE, FL 32601
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
23050	PRODUCT COMPONENTS CORP	30 LORRAINE AVE.	MT VERNON, NY 10553
49671	RCA CORPORATION	30 ROCKEFELLER PLAZA	NEW YORK, NY 10020
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
76545	MUELLER ELECTRIC CO.	1583 EAST 31ST ST.	CLEVELAND, OH 44114
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
79727	C-W INDUSTRIES	550 DAVISVILLE RD., P O BOX 96	WARMINSTER, PA 18974
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80710	ALLEGHENY LUDLUM STEEL CORP., A DIVISION OF ALLEGHENY LUDLUM INDUSTRIES, INC.	BRACKENRIDGE WORKS, RIVER AVE.	BRACKENRIDGE, PA 15014
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641
98278	MALCO A MICRODOT COMPANY, INC. CONNECTOR AND CABLE DIVISION	220 PASADENA AVE.	SOUTH PASADENA, CA 91030

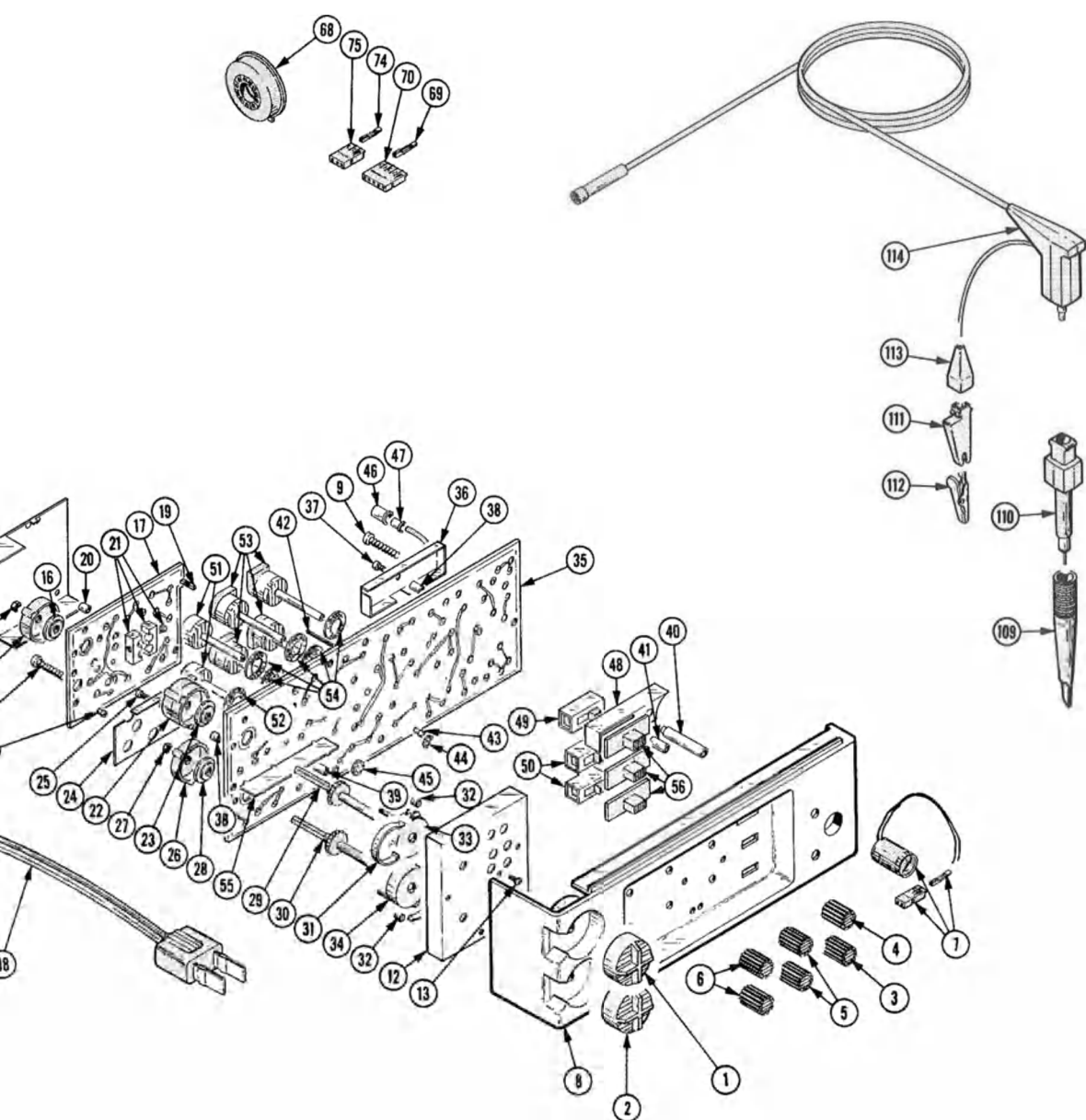
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	366-1337-04		1		KNOB:GRAY--VOLTS/DI	80009	366-1337-04
	214-1616-00		1		. SPR,HLCL,TRSN:0.23 ID X 0.282 OD X 0.15"L	80009	214-1616-00
-2	366-1337-03		1		KNOB:GRAY--SEC/DIV	80009	366-1337-03
	214-1616-00		1		. SPR,HLCL,TRSN:0.23 ID X 0.282 OD X 0.15"L	80009	214-1616-00
-3	366-1322-04		1		KNOB:GRAY--TRIG	80009	366-1322-04
-4	366-1322-06		1		KNOB:GRAY--INT	80009	366-1322-06
-5	366-1322-02		2		KNOB:DARK GRAY--VAR	80009	366-1322-02
-6	366-1322-01		2		KNOB:GRAY--POS	80009	366-1322-01
-7	-----		1		METER,ELEC FREQ:(SEE M676 EPL)		
-8	333-1444-02		1		PANEL,SIDE:221	80009	333-1444-02
	672-0058-00		1		CKT BOARD ASSY:INPUT HORIZ AND VERTICAL (ATTACHING PARTS)	80009	672-0058-00
-9	211-0016-00		2		SCREW,MACHINE:4-40 X 0.625 INCH,PNH STL - - - * - - -	83385	OBD
	-----		-		CKT BOARD ASSY INCLUDES:		
-10	337-1845-00		1		SHLD,ELECTRICAL:PREAMPLIFIER,INNER (ATTACHING PARTS)	80009	337-1845-00
-11	211-0069-00		1		. SCREW,MACHINE:2-56 X 0.125 INCH,PNH STL	77250	OBD
	210-0405-00		1		. NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS - - - * - - -	73743	2X12157-402
-12	337-1870-00		1		. SHLD,ELECTRICAL:ATTENUATOR FRONT (ATTACHING PARTS)	80009	337-1870-00
-13	211-0069-00		1		. SCREW,MACHINE:2-56 X 0.125 INCH,PNH STL - - - * - - -	77250	OBD
-14	200-1232-00		1		. COVER,RTRY SW:CIRCUIT BOARD (ATTACHING PARTS)	80009	200-1232-00
-15	210-0405-00		2		. NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS - - - * - - -	73743	2X12157-402
-16	401-0127-01		1		. ROTOR,ELEC SW:W/CONTACTS	80009	401-0127-01
-17	-----		1		CKT BOARD ASSY:--PREAMPLIFIER(SEE A2 EPL)		
-18	136-0252-04		26		. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-19	136-0327-01	B010100 B021784	5		. SOCKET,PIN TERM:0.067 INCH DIA	00779	86281-2
	136-0263-04	B021785	5		. SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	48059
-20	129-0437-00		1		. SPACER,POST:0.165 L,W/2-56 TAP 1 END,BRS	80009	129-0437-00
-21	-----		1		. TRANSISTOR,ASSY:W/HEATSINK(SEE Q136A,B EPL)		
-22	380-0322-00		1		HOUSING,SWITCH:POLYCARBONATE	80009	380-0322-00
-23	401-0127-01		1		. ROTOR,ELEC SW:W/CONTACTS	80009	401-0127-01
-24	337-1844-00		1		. SHLD,ELECTRICAL:PREAMPLIFIER,OUTER (ATTACHING PARTS)	80009	337-1844-00
-25	211-0069-00		1		. SCREW,MACHINE:2-56 X 0.125 INCH,PNH STL - - - * - - -	77250	OBD
-26	200-1232-00		1		. COVER,RTRY SW:CIRCUIT BOARD (ATTACHING PARTS)	80009	200-1232-00
-27	210-0405-00		3		. NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS - - - * - - -	73743	2X12157-402
-28	401-0127-01		1		. ROTOR,ELEC SW:W/CONTACTS	80009	401-0127-01
-29	214-1863-01		1		. DETENT,RTRY SW:WITH CONTACTS	80009	214-1863-01
-30	214-1875-01		1		. DETENT,RTRY SW:WITH CONTACTS	80009	214-1875-01
-31	214-1579-00		2		. SPRING,DETENT:0.59 ID X 0.08 W X 0.01 THK	80009	214-1579-00
-32	214-1127-00		2		. ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-33	380-0244-01		1		. HOUSING,SWITCH:POLYCARBONATE	80009	380-0244-01
-34	380-0244-00		1		. HOUSING,SWITCH:POLYCARBONATE	80009	380-0244-00
-35	-----		1		CKT BOARD ASSY:INPUT(SEE A1 EPL)		
-36	337-1877-00		1		. SHLD,ELECTRICAL:INPUT CPLG SWITCH,REAR (ATTACHING PARTS)	80009	337-1877-00
-37	211-0069-00		1		. SCREW,MACHINE:2-56 X 0.125 INCH,PNH STL - - - * - - -	77250	OBD
-38	129-0437-00		2		. SPACER,POST:0.165 L,W/2-56 TAP 1 END,BRS	80009	129-0437-00
-39	129-0436-00	B010100 B022132	1		. SPACER,POST:0.37 L,W/2-56TAP 1 END,BRS	80009	129-0436-00
	129-0436-01	B022133	1		. SPACER,POST:0.188 L,W/2-56 THD THRU,BRASS	80009	129-0436-01
	337-1868-00	B010100 B022132	1		. SHLD,ELECTRICAL:VOLTS PER DIVISION SWITCH	80009	337-1868-00
	337-1868-01	B022133	1		. SHIELD,ELEC:TIME-VOLTS DIV 221	80009	337-1868-01
-40	129-0312-00		2		. POST,CONTACT:HORIZONTAL INPUT & GROUND	80009	129-0312-00

Replaceable Mechanical Parts—221 Service

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-41	361-0569-00		1	.	SPACER,SLEEVE:0.188 OD X 0.40 INCH LONG	80009	361-0569-00
-42	131-0787-00		30	.	CONTACT,ELEC:0.64 INCH LONG	22526	47359
	131-0608-00		2	.	TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-43	136-0252-04		43	.	SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-44	136-0350-01		13	.	SHLD,PL-IN ELEK:TRANSISTOR,3 CONTACT	80009	136-0350-01
-45	136-0366-01		1	.	SKT,PL-IN ELEK:TRANSISTOR,6 CONTACT	80009	136-0366-01
-46	210-0774-00		1	.	EYELET,METALLIC:0.152 OD X 0.245 INCH L,BRS	80009	210-0774-00
-47	210-0775-00		1	.	EYELET,METALLIC:0.126 OD X 0.23 INCH L,BRS	80009	210-0775-00
-48	337-1869-00		1	.	SHLD,ELECTRICAL:INPUT CPLG SW FRONT	80009	337-1869-00
-49	260-0984-01		1	.	SWITCH,SLIDE:DP3T W/PLASTIC PLATE	79727	G-128SPG/
-50	260-0723-00		2	.	SWITCH,SLIDE:DPDT,0.5A,125VAC	79727	GF126-0028
-51	-----		2	.	RES.,VARIABLE:(SEE R413,R518 EPL) (ATTACHING PARTS)		
-52	210-0933-00		2	.	WASHER,NONMETAL:0.625"DIA,0.002 MICA	08530	OBD
-53	-----		4	.	RES.,VARIABLE:(SEE R213,R352,R418,R738 EPL) (ATTACHING PARTS)		
-54	210-0933-00		4	.	WASHER,NONMETAL:0.625"DIA,0.002 MICA	08530	OBD
-55	337-1868-00		1	.	SHLD,ELECTRICAL:VOLTS PER DIVISION SWITCH	80009	337-1868-00
-56	200-1480-00		3	.	COVER,SLIDE SW:DARK GRAY PLASTIC	80009	200-1480-00
-57	200-1468-00		1	.	COVER,CORD WRAP:PROBE,UPPER	80009	200-1468-00
-58	437-0146-01		1	.	CABINET,SCOPE:TOP & BOTTOM (ATTACHING PARTS)	80009	437-0146-01
-59	211-0019-00		2	.	SCREW,MACHINE:4-40 X 1.0 INCH,PNH STL	83385	OBD
-60	211-0166-00		2	.	SCREW,MACHINE:4-40 X 1.750,PNH,STL,CD PL	83385	OBD
	-----		-	.	CABINET ASSY INCLUDES:		
	348-0254-01		4	.	FOOT,CABINET:BLACK RUBBER	80009	348-0254-01
-61	-----		1	.	CKT BOARD ASSY:--AMPLIFIER(SEE A3 EPL)		
-62	131-0608-00		3	.	TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-63	131-1172-00		1	.	CONTACT,ELEC:CKT CARD GROUND	80009	131-1172-00
-64	136-0252-04		76	.	SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-65	136-0328-02		15	.	SOCKET,PIN TERM:HORIZONTAL	00779	86282-2
-66	253-0154-00		4	.	TAPE,PRESS.SENS:0.125"THK	18121	MT8
-67	342-0205-00		1	.	INSULATOR,FILM:PREAMPLIFIER CARD	80009	343-0205-00
	136-0582-00		1	.	SKT,PL-IN ELEK:ELECTRON TUBE,11 CONTACT	80009	136-0582-00
-68	136-0555-00		1	.	SKT,PL-IN ELEK:ELECTRON TUBE,11 CONTACT	80009	136-0555-00
	131-0371-00	B010100 B023169	7	.	CONTACT,ELEC:FOR NO.26 AWG WIRE	98278	122-0182-019
	131-1109-01	B023170	11	.	CONNECTOR,TERM.:20-26 AWG,U/00.04 OD PIN	80009	131-1109-01
-69	131-0707-00	B010100 B023169	4	.	CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	131-0707-00	B023170	11	.	CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-70	352-0163-01		1	.	CONN BODY,PL,EL:5 WIRE BROWN	80009	352-0163-01
	-----		2	.	BATTERY ASSY:(SEE BT632/BT633 EPL)		
	-----		-	.	EACH BATTERY ASSY INCLUDES:		
-71	200-1238-02	B010100 B023549	4	.	COVER,BAT PACK:PLASTIC	80009	200-1238-02
	200-1238-01	B023550	4	.	COVER,BAT SET:PLASTIC,BLACK	80009	200-1238-01
-72	253-0153-00		FT	.	TAPE,PRESS.SENS:0.25 W X 0.125"THK FOAM	18121	P7/PVC
-73	146-0016-01	B010100 B023549	PK	.	BATTERY SET:6V,600MAH	19209	41B906F003-G1
	146-0026-00	B023550	PK	.	BATTERY SET:6V,660 MAH,5ACELL	19209	41B906FD02-G1
	198-2209-00	B010100 B023549	1	.	WIRE SET,ELEC:	80009	198-2209-00
	198-3183-00	B023550	1	.	WIRE SET,ELEC:	80009	198-3183-00
-74	131-0707-00		1	.	CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-75	352-0161-00		1	.	HLDR,TERM CONN:3 WIRE BLACK	80009	352-0161-00
-76	378-0691-00		1	.	FILTER,LT,CRT:BLUE	80009	378-0691-00
	331-0445-00	XB023860	1	.	MASK,CRT SCALE:	80009	331-0445-00
-77	386-1999-00		1	.	SUPPORT,CRT:FRONT	80009	386-1999-00
-78	361-0593-00		1	.	SPACER,ELCTR N T:FRONT	80009	361-0593-00
-79	354-0423-00		1	.	RING,SPRT,CRT:RUBBER	80009	354-0423-00
-80	337-1458-00		1	.	SHLD,ELECTRON T:CATHODE RAY TUBE (ATTACHING PARTS)	80710	337-1458-00-D
-81	386-2679-00		1	.	SPRT,CRT SHLD:REAR	80009	386-2679-00
-82	211-0213-00		1	.	SCREW,MACHINE:4-40 X 0.312 INCH,PNH NYLON	23050	OBD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-83	-----		1		CKT BOARD ASSY:--POWER SUPPLY(SEE A4 EPL)		
-84	131-0608-00		10		. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-85	131-1172-00		1		. CONTACT,ELEC:CKT CARD GROUND	80009	131-1172-00
-86	136-0252-04		33		. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-87	136-0328-02		10		. SOCKET,PIN TERM:HORIZONTAL	00779	86282-2
-88	161-0078-00		1		. CABLE ASSY,PWR,:2 WIRE,48 INCH LONG	16428	KG12127
-89	214-0579-00		5		. TERM,TEST POINT:BRZ CD PL	80009	214-0579-00
-90	253-0056-00		1		. CUSHION:POLYURETHANE FOAM,PRESSURE SENS	04963	4116
-91	253-0154-00		4		. TAPE,PRESS.SENS:0.125"THK	18121	MT8
-92	342-0213-00		1		. INSULATOR,FILM:ELECTRON TUBE SHIELD	80009	343-0213-00
-93	337-1871-00		1		. SHLD,ELECTRICAL:TRANSFORMER (ATTACHING PARTS)	80009	337-1871-00
-94	211-0163-00		1		. SCREW,MACHINE:2-56 X 0.188 INCH,FLH NYLON - - - * - - -	95987	N-25-0.19
-95	129-0439-00		1		. SPACER,POST:0.690 L,W/2-56 THD,BRASS	80009	129-0439-00
-96	-----		2		. TRANSISTOR:(SEE Q622,Q626 EPL) (ATTACHING PARTS)		
-97	210-0406-00		2		. NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-98	211-0008-00		2		. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-99	210-1178-00		2		. WSHR,SHOULDERED:FOR MTG TO-220 TRANSISTOR - - - * - - -	49671	DF 137A
-100	342-0202-00	B010100 B022705	2		. INSULATOR,PLATE:TRANSISTOR	01295	10-21-023-106
	342-0332-00	B022706	2		. INSULATOR PLATE:TRANSISTOR,SILICONE RUBBER	08530	OBD
-101	344-0255-00		2		. CLIP,ELECTRICAL:FUSE MOUNT	80009	344-0255-00
-102	342-0176-01		1		. INSULATOR,FILM:POWER SUPPLY CARD	80009	342-0176-00
-103	200-1467-00		1		COVER,CORD WRAP:PROBE,LOWER	80009	200-1467-00
-104	334-2117-00		1		LABEL,IDENT:WARNING FOR 22	80009	334-2117-00
-105	348-0254-00		4		FOOT,CABINET:0.344 H X 0.285 W X 0.8"L	80009	348-0254-00
-106	348-0285-00		1		FLIP-STAND,CAB:1.94 H X 3.424 INCH WIDE	80009	348-0285-00
-107	355-0181-00		2		STUD,CRYG,HDL:0.312 DIA X 0.50 INCH LONG	80009	355-0181-00
-108	200-1400-00		1		COVER,PLUG:POWER CORD	80009	200-1400-00
	010-0269-00	B010100 B022874	1		PROBE,VOLTAGE:	80009	010-0269-00
	010-0269-01	B022875	1		PROBE,VOLTAGE:1M OHM/200K OHM,DARK GRAY	80009	010-0269-01
-109	013-0107-02		1		. TIP,TEST PROD:RETRACTABLE HOOK	80009	013-0107-02
-110	204-0594-00	B010100 B022874	1		. BODY,PROBE:5 X	80009	204-0594-00
	204-0594-04	B022875	1		. BODY ASSY,PROBE:	80009	204-0594-04
-111	200-1280-00	B010100 B022874X	1		. COVER,ELEC CLIP:YELLOW VINYL	80009	200-1280-00
-112	344-0024-00	B010100 B022874X	1		. CLIP,ELECTRICAL:ALLIGATOR TYPE	76545	56896-000
-113	200-1281-00	B010100 B022874X	1		. CABLE NIP,ELEC:0.125 ID-0.174 SQ X 0.75	80009	200-1281-00
	175-0940-01	B022875	1		. LEAD,ELECTRICAL:PROBE COMMON W/CLIP	80009	175-0940-01
-114	175-1498-00	B010100 B022874	1		. CABLE ASSY,SP:48.55 INCH LONG	80009	175-1498-00
	175-1498-01	B022875	1		. CABLE ASSY,RF:	80009	175-1498-01





ACCESSORIES

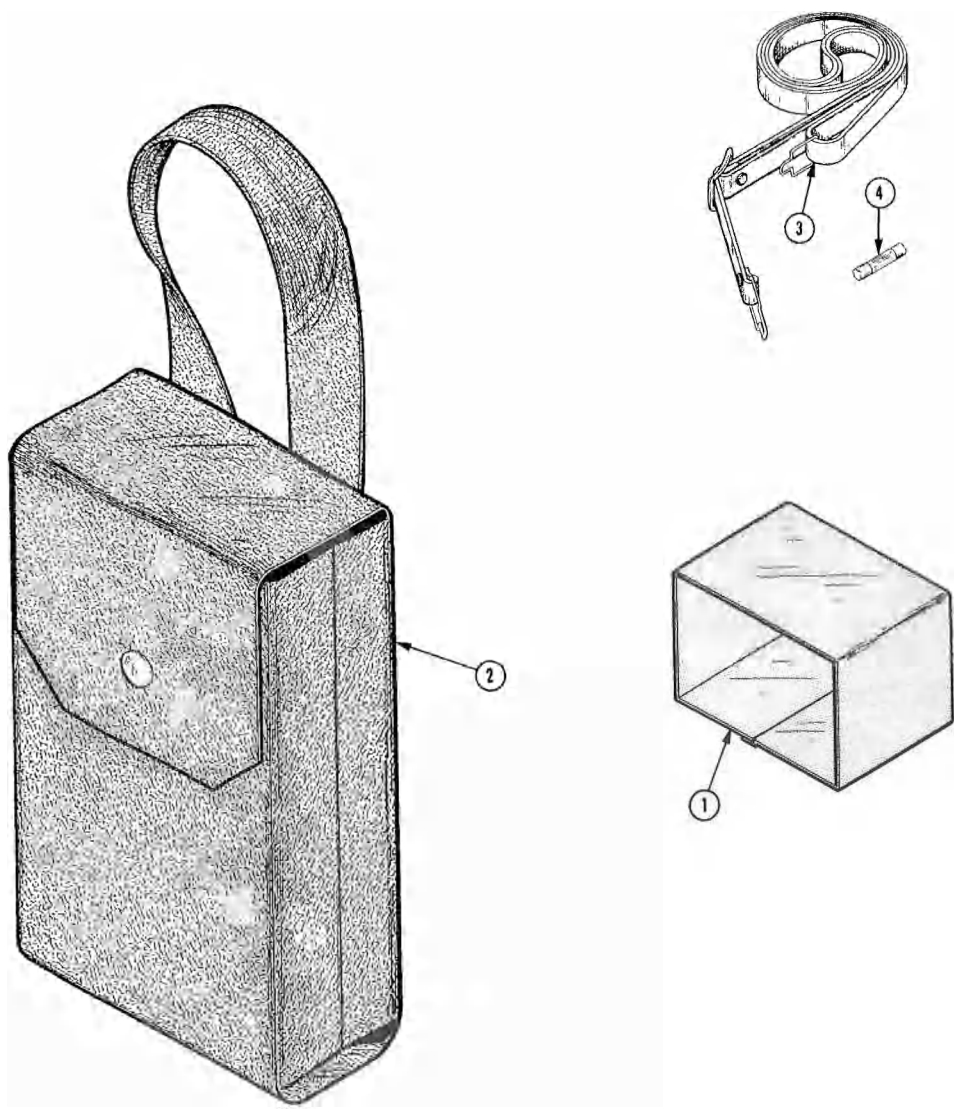


Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty						Name & Description	Mfr Code	Mfr Part Number
		Eff	Discont		1	2	3	4	5			
2-1	016-0199-01			1						VIEWING HOOD:	80009	016-0199-01
-2	016-0512-00			1						CASE, CARRYING:	80009	016-0512-00
-3	346-0104-00			1						STRAP, CARRYING:	17516	4188-BA
-4	159-0080-00			2						FUSE, CARTRIDGE: 0.2A, 250V, SLOW-BLOW	75915	213200
	070-1572-00			1						MANUAL, TECH: OPERATORS (NOT SHOWN)	80009	070-1572-00
	070-1573-01			1						MANUAL, TECH: SERVICE (NOT SHOWN)	80009	070-1573-00

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω .	107 - Risetime less than 3.0 ns into 50 Ω .
108	PG 501 - 5 V output pulse; 3.5 ns Risetime	108 - 10 V output pulse 1 ns Risetime
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay
PG 508 replaces 114	Performance of replacement equipment is the same or better than equipment being replaced.	
115		
2101		
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0532-01		
SG 504 replaces 067-0532-01	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0650-00		
TG 501 replaces 180, 180A	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	181 - Multiple time-marks
184		184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μ s.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Separate trigger pulses, from 5 sec to 0.1 μ s. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

REV B, JUN 1978